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Petroleum Refiner

Gulf Publishing Company

DECEMBER
1957

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COST FINDER
Which Depreciation Rate is Best 137

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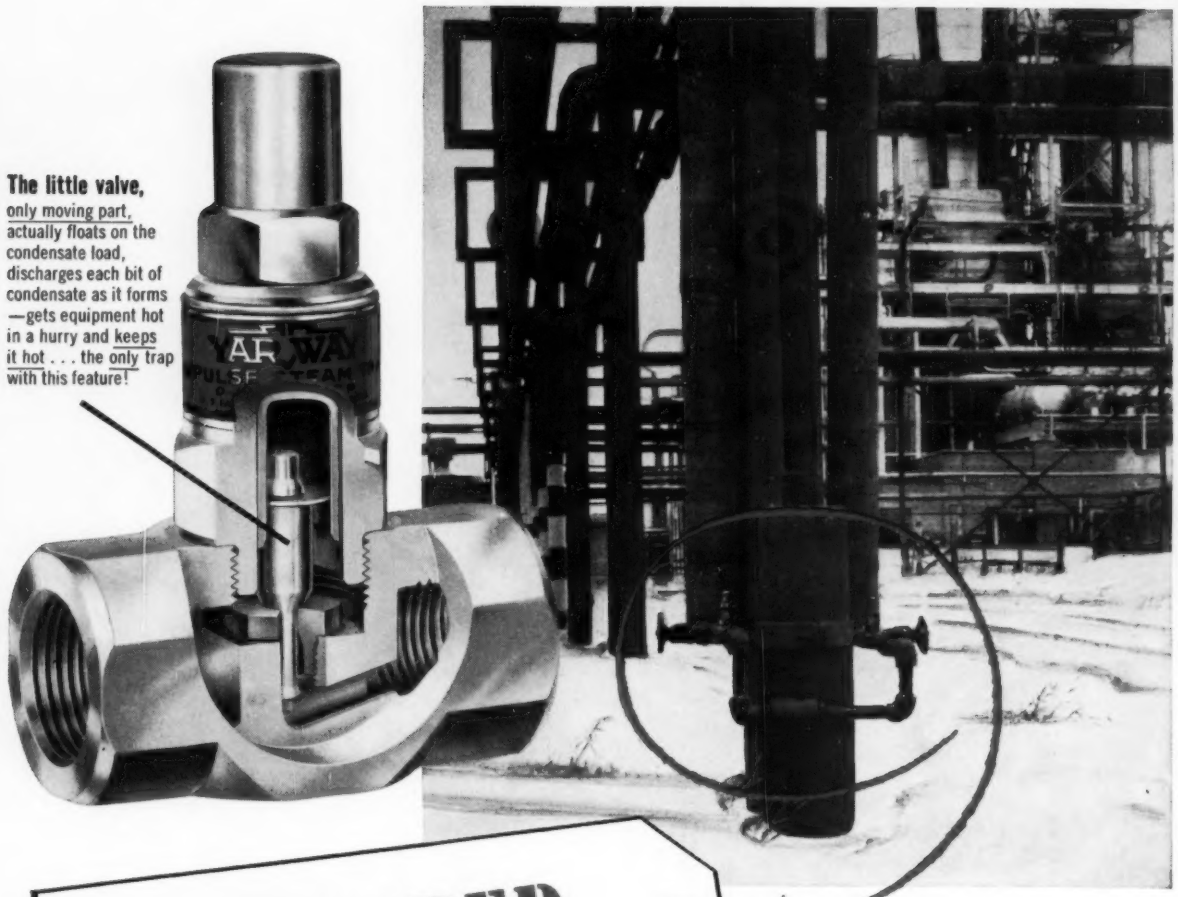

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Volume 36, No. 12 December, 1957

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Petroleum Refiner
REFINING • PETROCHEMICALS • NATURAL GASOLINE

A Quick Look

at This Issue

These handy digests permit checking ☑ the articles you want to read first.

Disaster Planning Special Report

ADVANCE PLANNING is the key to disaster preparedness. And every refinery disaster plan should include the following eight areas: Organization, responsibilities, procedures, training, mutual aid, communications, transportation and public relations.

In this special report you will find the most practical disaster planning ideas experience has provided to date for each of these eight areas.

☐ **Plan for Disaster** . . . After studying several successful disaster programs, the most workable ideas for both large and small refinery operations were abstracted and incorporated in this over-all plan to: (1) Organize for disaster; (2) Establish responsibilities; (3) Set up disaster procedures. Plus, helpful suggestions for preservation of vital records, turn to **Page 102.**

☐ **Training for Disaster** . . . Too many refineries put too little stress on advance planning and training for disaster. On **Page 109,** you will find the tragic results of inadequate training, suggested training procedures, plus a case history of Tidewater's training program at the company's new Delaware refinery.

☐ **Mutual Aid** . . . Estimates are that less than 20 U. S. industrial areas now have mutual aid plans. Many more are needed. If you have plans to set up mutual aid in your area, turn to **Page 115** for a handy check-list which will help you solve pre-organization problems, organize the plan and to contact other sources for information.

☐ **Communications** . . . Efficient and effective control of disasters is dependent to a large degree on the rapid transmission of accurate information and directives. Here is an effective intra-plant and off-the-plant communications system that is applicable to any refinery operation. Turn to **Page 117.**

☐ **Disaster and the Public** . . . Indiana Standard's handling of the public during the 1955 Whiting (Indiana) refinery disaster is recognized as one of the outstanding oil industry public relations efforts in re-

Please Turn Page ➡

A Quick Look at This Issue . . .

cent years. Turn to **Page 118** for an informative case history describing the advance planning and careful organization that went into this vital area of disaster preparedness.

☐ **Check List for Disaster** . . . Here is a handy check list consisting of 18 questions based on the most important aspects of disaster planning mentioned in the special report. Compare your present refinery plan with the points covered in the list; you may find some reminders applicable to your own operation. Turn to **Page 120.**

☐ **Which Polyethylene Is "Best"?** . . . The best polyethylene is that polymer best suited to your specific purpose. Physical properties are affected by molecular weight, molecular weight distribution and degree of crystallinity. Select the polymer with the physical properties best suited to your needs. Turn to **Page 121.**

☐ **Know Your Asphalts—Part 4** . . . The crude source and method of manufacture are major factors in determining the quality of asphalt. Here are some pipe still operation tips that can improve the quality of your asphalt. Typical operating conditions are given for a mid-continent crude. Add this to your asphalt data. Turn to **Page 124.**

☐ **Recent Developments in Fluid Flow** . . . are covered in a down-to-earth manner in this semi-technical article. Have you let the developments in this field slide for the past ten years or so? Then you can bring yourself up-to-date by reading this information-packed article, starting on **Page 125.**

☐ **Use Graphs and Simplify Footing Design** . . . Structural designers often rely on trial and error procedures in determining satisfactory sizes for their foundations. Here's an easy, graphical way to obtain the economical sizes of octagonal and square footings used in your plant. For complete details, turn to **Page 130.**

☐ **Simplified V/L Flash Calculations** . . . Two methods for calculating vapor-liquid flash ratios are presented. By choosing another function, all trial v/l ratios are made valid. Make-up or recycle rate can be chosen as this function. Add this to your work notebook. Turn to **Page 133.**

☐ **Which Depreciation Method Is Best?** . . . Here are descriptions of seven different methods which are in current use. All have faults and only the best includes inflation. These analyses, as well as several innovations that are introduced, can help you in studying your present depreciation method. Turn to **Page 137.**

☐ **Thermo Data for Petrochemicals (Part XXIII)** . . . Interpolation coefficients make easy the calculation of thermodynamic data for intermediate pressures from values given in the National Bureau of Standards Circular 564. The four-point Lagrangian method gives very accurate data from these tables. This is a must for your work book. Turn to **Page 147.**

☐ **Which CO_2 Removal Scheme Is Best?** . . . Seven different processing schemes are compared on an equivalent economic basis. Operating variables and economic differences are discussed. Using this article, you can quickly evaluate the economics of your carbon dioxide removal plant. Turn to **Page 149.**

☐ **Generalized Z Chart for Low Pressures** . . . With an accuracy of 0.10 percent of the actual value for light hydrocarbons. Replace the old low pressure chart in your handbook with this one with new up-to-date experimental data to back it up. See **Page 153.**

☐ **This Equation Gives Viscosity** . . . Here is a new modified rate equation that correlates the available viscosity data for normal paraffins, benzene, 1-butene, and methylcyclopentane over a wide temperature range. The equation should be applicaple for other hydrocarbons in the aromatic, isoparaffin, olefin and cycloparaffin families. Add this to your process design notebook. Turn to **Page 155.**

☐ **Radial Deformation of Rings Simplified** . . . Annular rings are used to transmit tranverse forces and moments into a circular shell. There have been extensive investigations concerning bending moments, shear and axial load distributions on rings, but little work has been done on radial deflection. The laborious method of calculating radial ring deformation may be replaced by these simplified solutions. For complete details, turn to **Page 159.**

☐ **Calculate Heater Tube Temperatures** . . . To properly select tube materials and specify tube wall thickness, the maximum tube-wall temperatures in a fired heater must be known. Here is a method for calculating the maximum expected tube-wall temperature. It will prove useful in specifying alternate operating conditions for existing heaters. Check your tube temperatures now, turn to **Page 165.**

☐ **Yardstick for Decision Makers** . . . Most articles on operations research are too general or they deal with various techniques of solution which tend to confuse clear understanding of the method. This article does neither. In a concise, clear style, the report explains operations research, outlines its applications and shows, in simple terms, how to set it up for profitable use. Turn to **Page 201.**

☐ **How to Fight Refinery Fires** . . . Knowing the conditions under which oil and its products burn is the key to fire control. Those conditions include knowledge of the vapor-air mixture of the burning product, and whether the fire is contained or uncontained. For the most effective ways to fight refinery fires according to these three conditions, turn to **Page 204.**

Petroleum Refiner

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TWO IMPORTANT ANNOUNCEMENTS for PR readers: (1) **William G. Dudley** has been named president of Gulf Publishing Co. which his father, the late Ray L. Dudley, founded. Bill Dudley, who also becomes publisher of PR, holds degrees in chemistry from both the Rice Institute and the University of Texas, a Bachelor of Arts, in chemical engineering from Rice and a Master of Science in chemistry from Texas. He was one of the youngest navigators in the Air Force's Pacific operations during World War II. Immediately following graduation he worked with the research staff of The Dow Chemical Co. He joined Gulf Publishing Co. in 1953, and has worked in various departments including editorial, advertising and market research.

(2) Our editorial chairman, **Dr. John McKetta** was honored during the past month by his election as a director of the (national) American Institute of Chemical Engineers.

Edmister for Xmas

FEW IF ANY SERIES presented by a technical magazine has enjoyed any wider popularity and acceptance than that received by Wayne Edmister's "Application of Thermodynamics to Hydrocarbon Processing" which appeared some years ago in PETROLEUM REFINER. After two separate series were presented, we promised we would bring you more of Edmister, additional information in this field. Well, the long wait has come to an end and here's the announcement for a Christmas present: In the January, 1958 issue, you will have the first part of the new series by Wayne Edmister under the title "Applied Hydrocarbon Thermodynamics."

Tell your non-subscribing friends that now's exactly the right time to use that postcard that faces PR's index page.

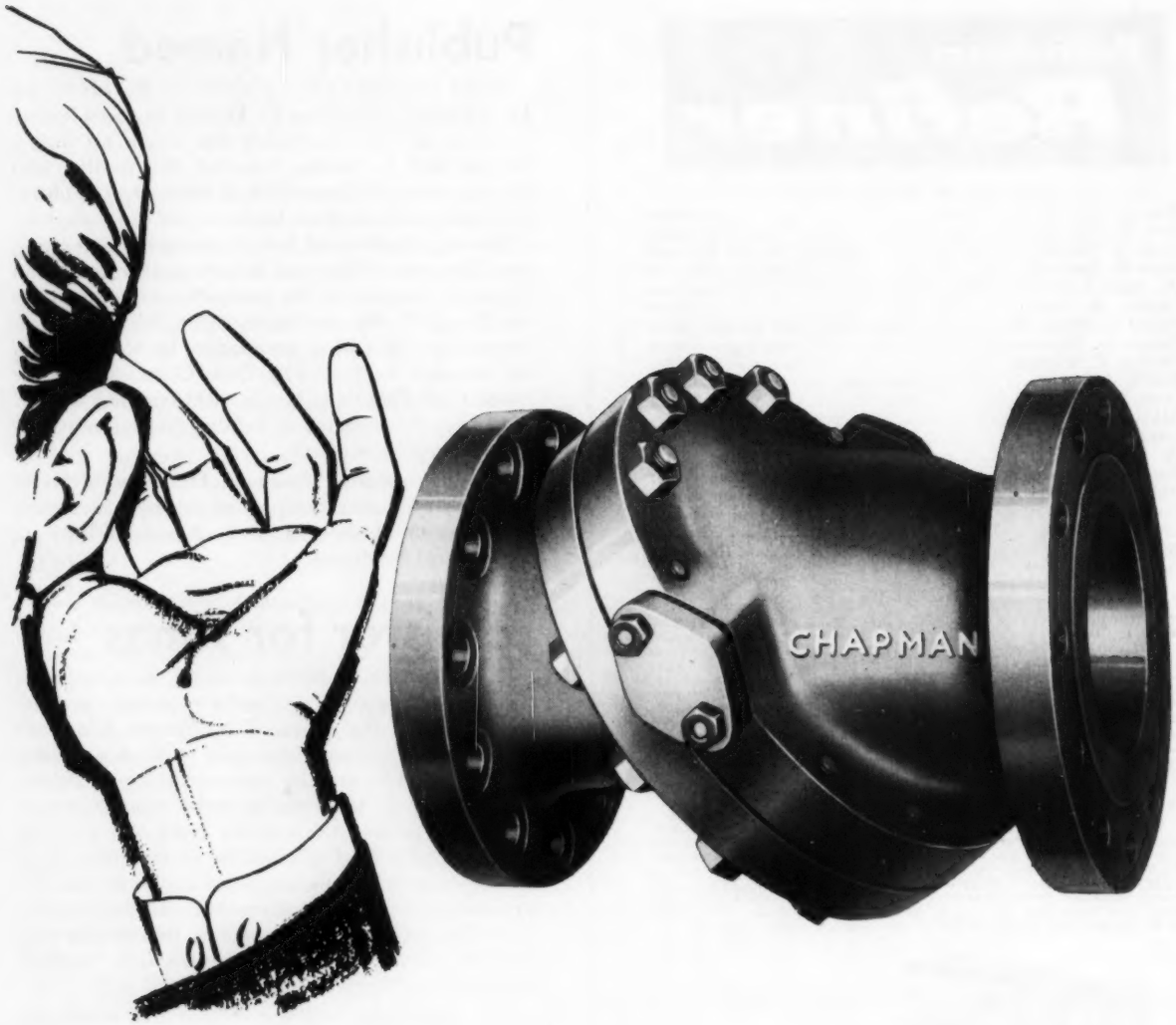
Which One? Both?

WE HAVE A COUPLE of hot shot reprints that you or some of your friends might be a hankerin' for. Either is available for $1.

- F. A. Zenz's eight-part series dealing with Fluid Catalyst Design Data completed in PR last month. It is an up-to-date orientation and appraisal of recent developments in fundamental studies in fluidization which ties together many loose ends of the subject to comprize an integrated picture both qualitatively and quantitatively.

- 1957 Petrochemical Process Handbook. This presents the flow charts of 95 manufacturing and 13 separation processes plus an over-all outlook for the entire petrochemical industry and specific forecasts on eight important petrochemicals.

Either or both would be worthwhile additions to the process man's library. Address Reprints, Box 2608, Houston 1, Texas and enclose your check.



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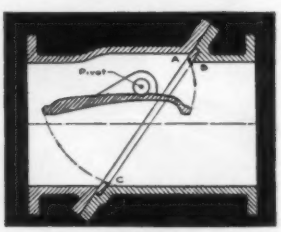

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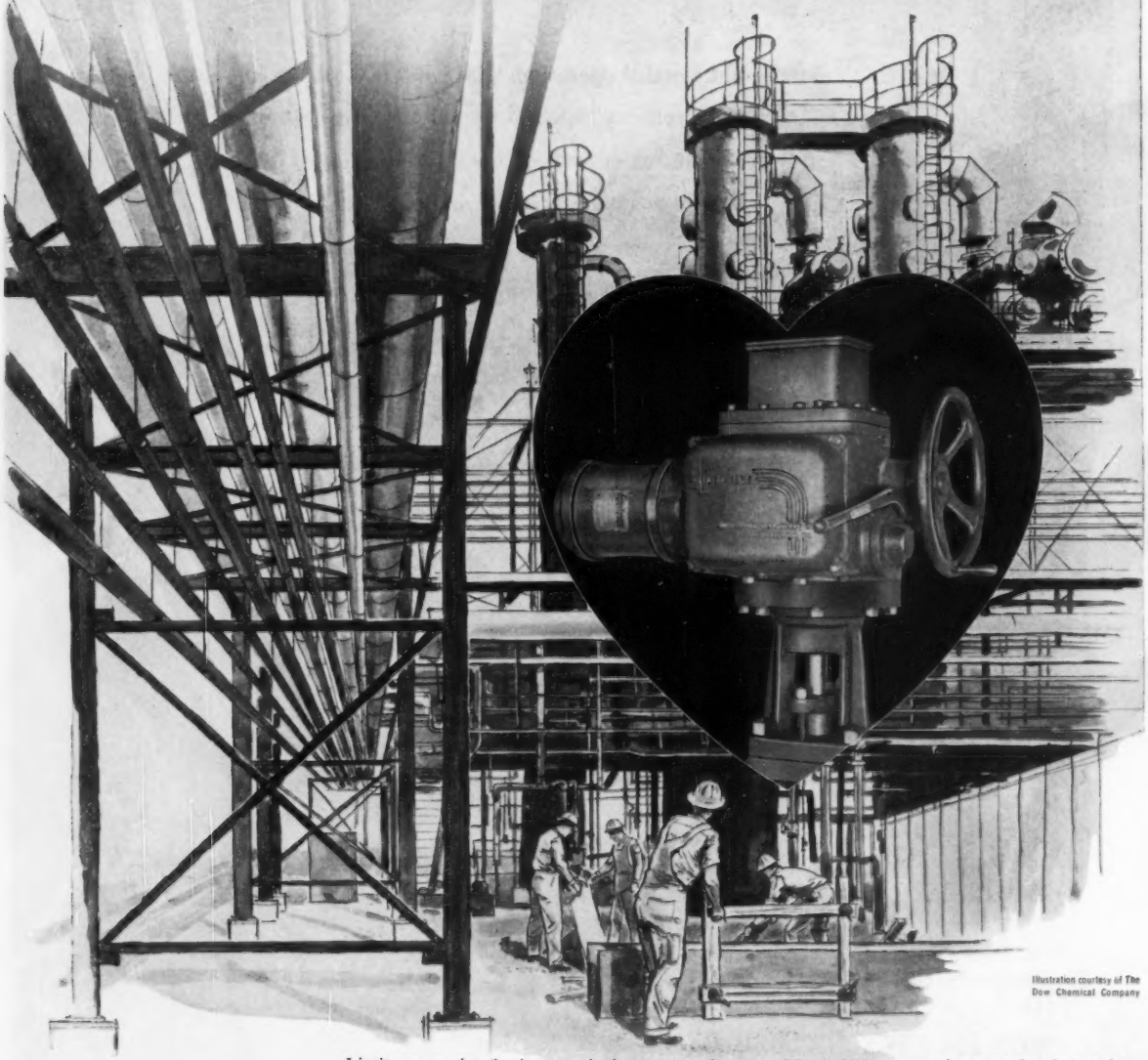

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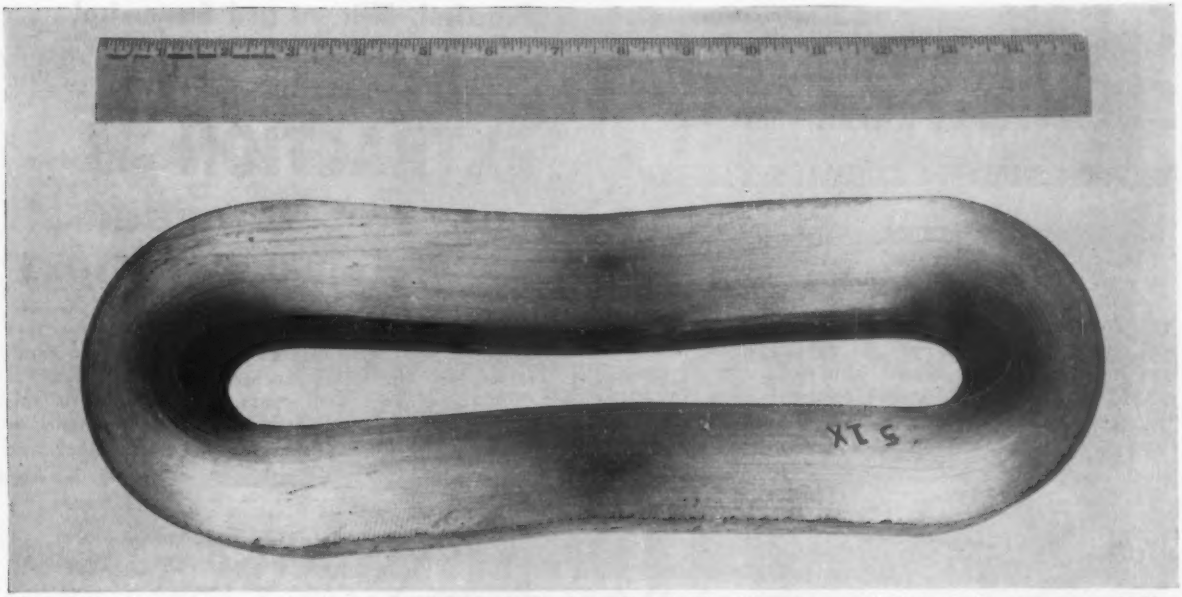

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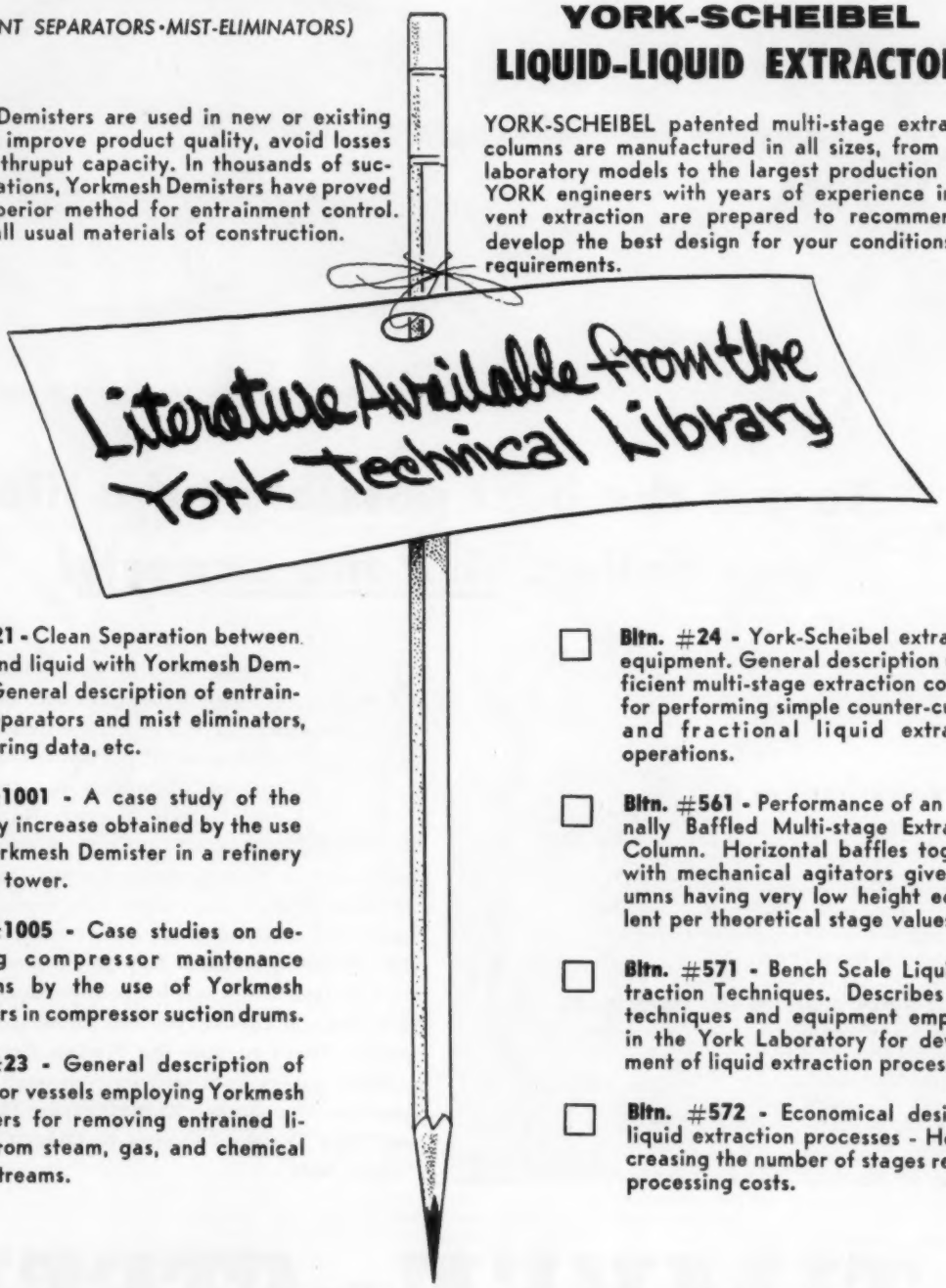

☐ **Bltn. #21** - Clean Separation between vapor and liquid with Yorkmesh Demisters. General description of entrainment separators and mist eliminators, engineering data, etc.

☐ **Bltn. #1001** - A case study of the capacity increase obtained by the use of a Yorkmesh Demister in a refinery vacuum tower.

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☐ **Bltn. #24** - York-Scheibel extraction equipment. General description of efficient multi-stage extraction columns for performing simple counter-current and fractional liquid extraction operations.

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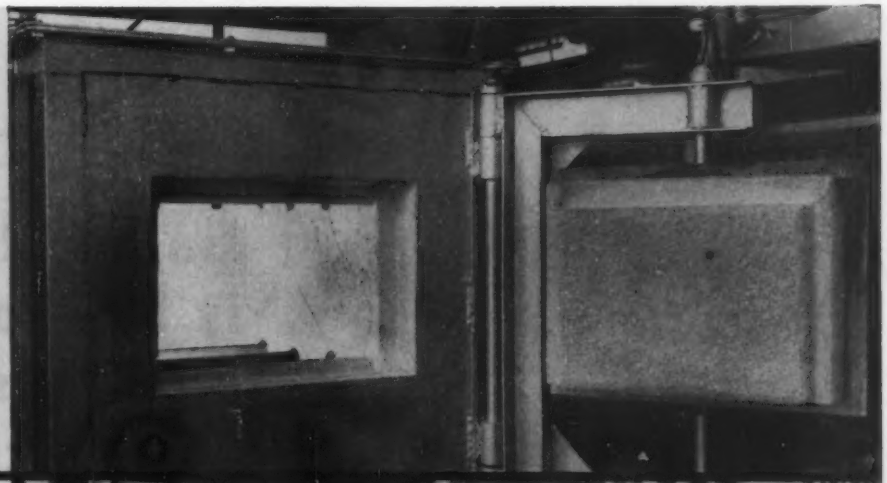

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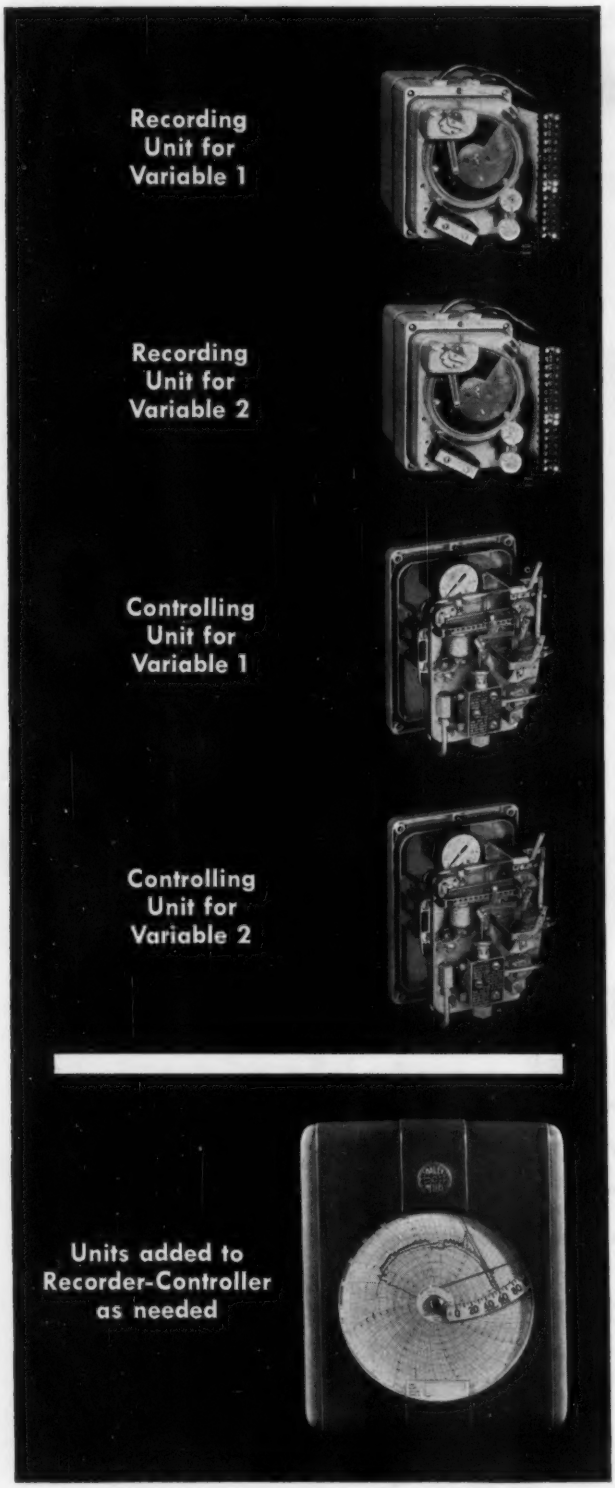

Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer.

G-42-1

Instruments and controls for power and process

BAILEY METER COMPANY

1043 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

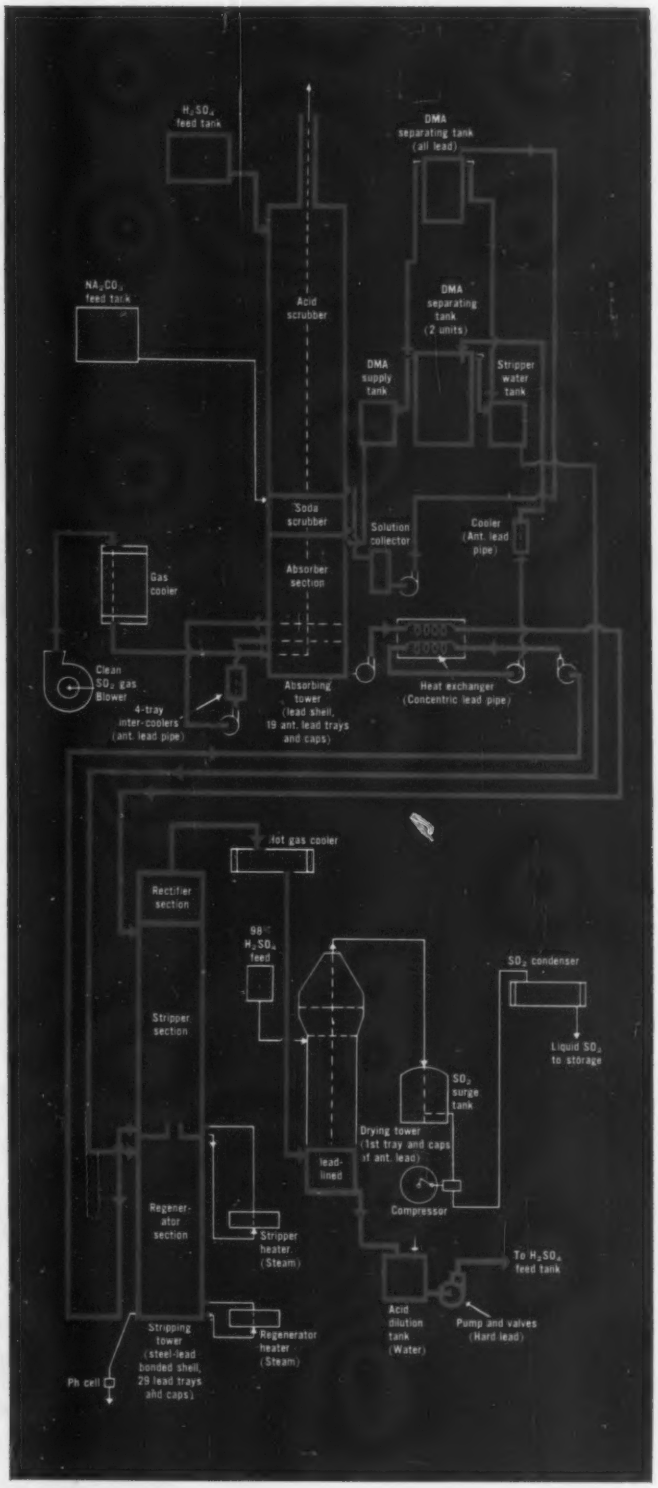
Where lead gives useful corrosion control

in liquid Sulphur Dioxide process vessels and piping

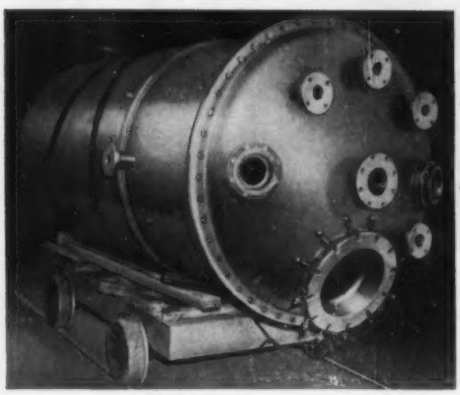
Hot SO_2 vapors and other oxidation products present in liquid SO_2 processing are "murder on metal." Even that old corrosive marauder, H_2SO_4 gets into the act.

As a result, *lead* practically lives with these acids and gases throughout the SO_2 process. In fact, the flow chart at the right is almost a continuous flow of *lead* applications. For ducts. For piping. For sheet lead linings in the larger units like the scrubbers and strippers. It is used with steel, with wood, with copper and, in some cases, with concrete. The result is low maintenance cost, facility of repair and consequent freedom from costly production stoppages.

If your process involves corrosive chemicals, look to *lead* for *long life, low maintenance and minimum loss of production due to down-time.*



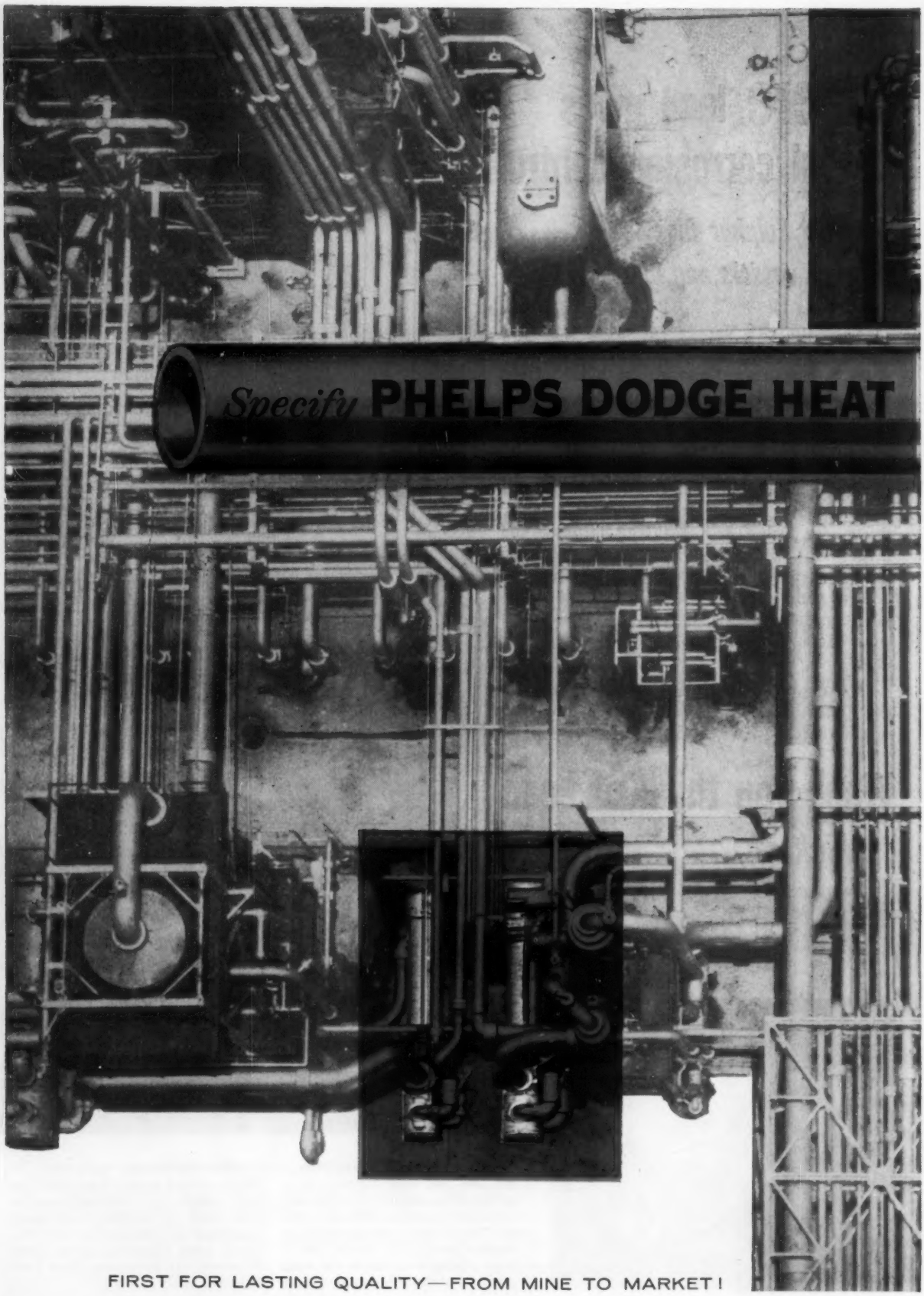
When you think of Lead ...*think of* National Lead



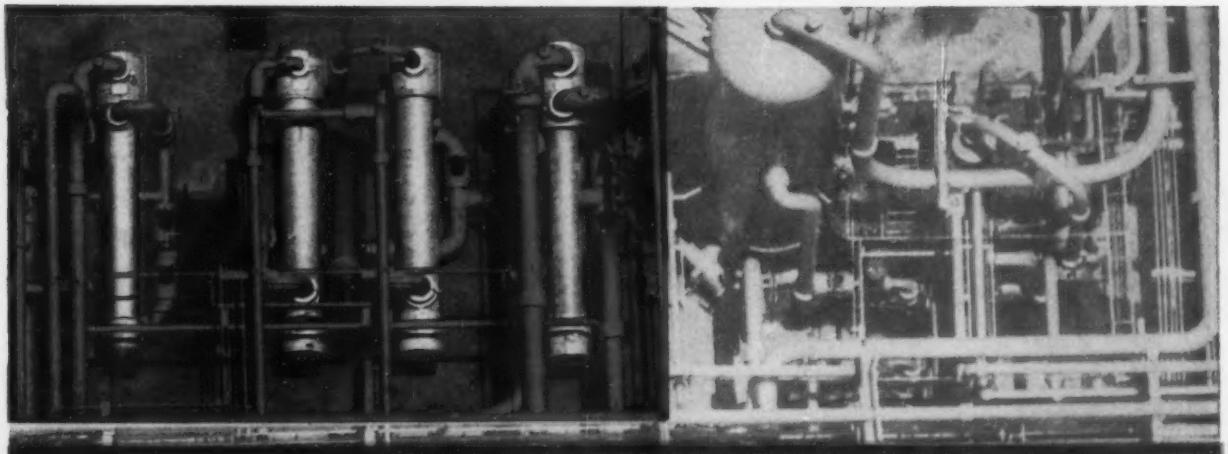
National Lead has the experience to get *lead* and steel together in a *bond* that defies severe pressure and temperature changes, vibration and creep. That's been proved not only in regular production "stock" items such as piping and valves but also in specially designed, complex lead process and storage equipment.

If you are enlarging or modernizing your processing facilities, now's a good time to get the facts about lead-lined equipment. Contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, New York.

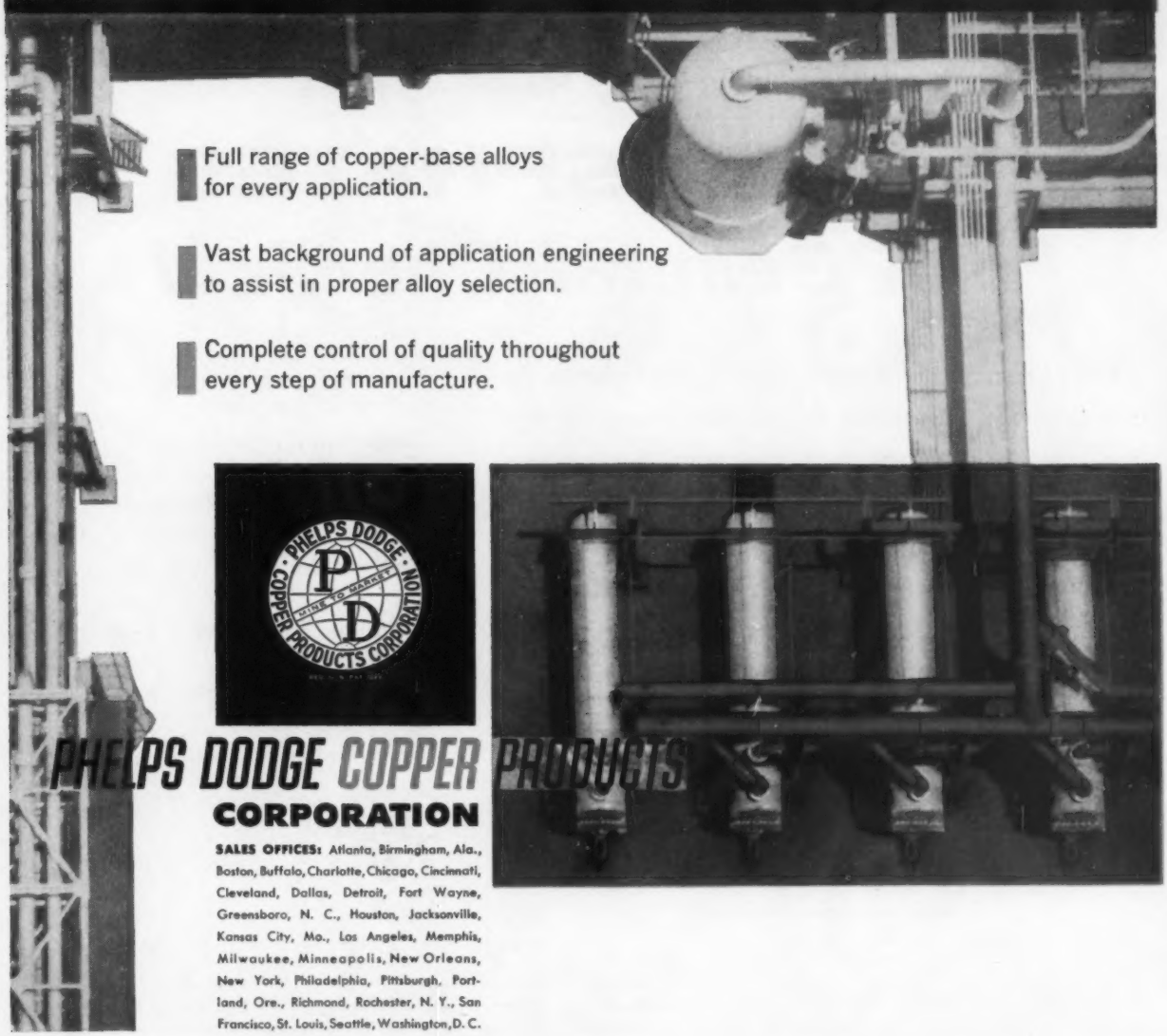
For more data on advertised products, use Readers' Service Cards, last page.



FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



EXCHANGER TUBES *for Longer Service!*



- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.

PHELPS DODGE COPPER PRODUCTS CORPORATION

MINE TO MARKET

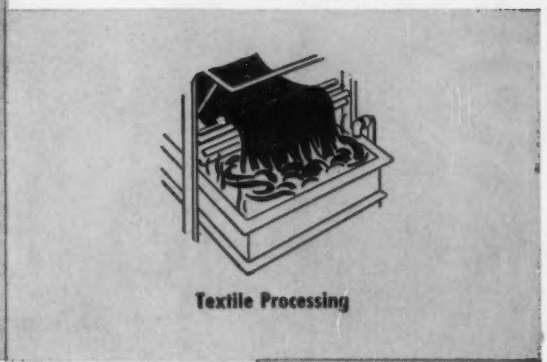
PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

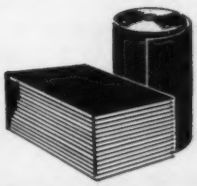
For more data on advertised products, use Readers' Service Cards, last page.

Oil Well Drilling

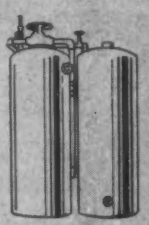
Soaps
Synthetic Detergents
Alkaline Cleaners



Textile Processing



As Deflocculating and Dispersing Agents



Water Softeners

Whatever your use...

for PHOSPHATES

call General Chemical

General Chemical has over 50 years of experience in the manufacture of phosphates. In that time, many developments which have made phosphates easier and more practical to use, have been pioneered by General Chemical research. This background of experience makes General Chemical your *best* source of supply for phosphates. The phosphates listed here are available in a variety of forms, suited to every need—all offering high quality and excellent uniformity. Call your nearest General Chemical sales office for specific information.

Sodium Tripolyphosphate
Powder & Granular

Trisodium Phosphate
Flake & Crystal

Tetrasodium Pyrophosphate
Anhydrous & Crystal, Reagent

Sodium Phosphate
Monobasic U.S.P.

Disodium Phosphate
Anhydrous

Potassium Phosphate
Mono & Dibasic, Purified

***also*—Phosphoric Acid**
Wet process, 65%
Food grade, 75%
N.F., 85%

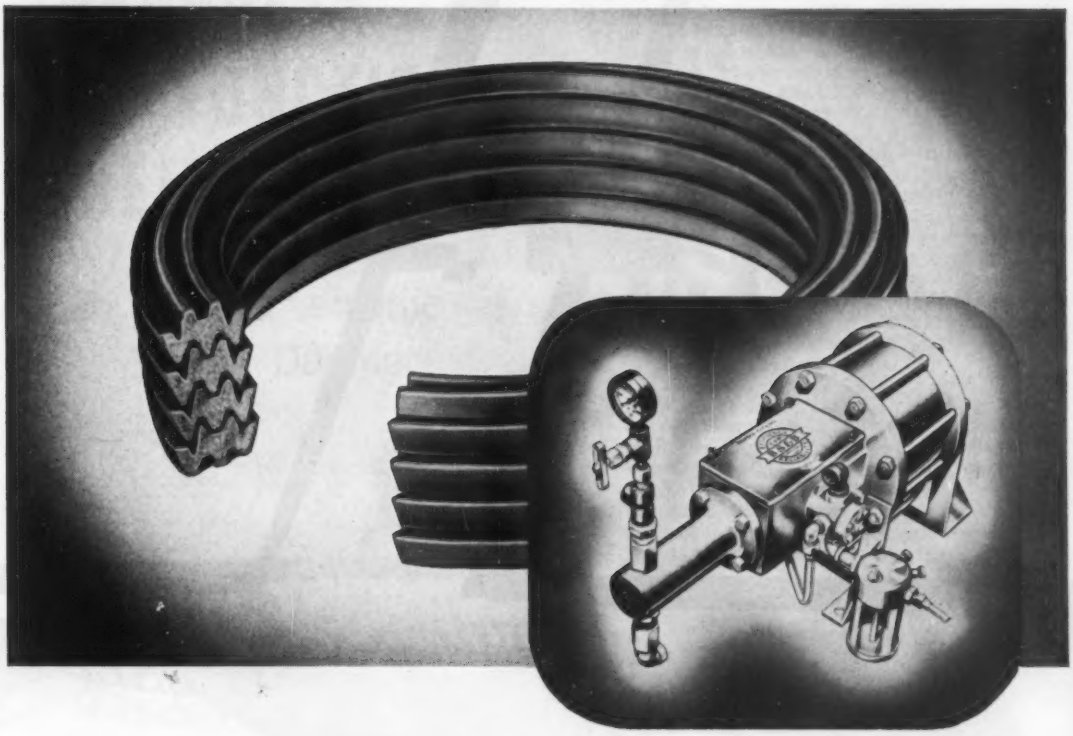
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

GC Allied Chemical

Basic Chemicals for American Industry

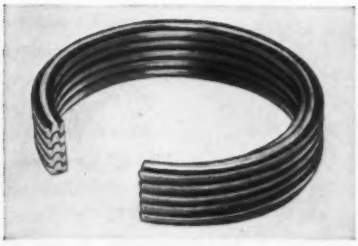
Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland (Miss.) • Cleveland (Ohio) • Denver • Detroit • Houston • Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia Pittsburgh • Providence • San Francisco • Seattle • St. Louis • Yakima (Wash.) **In Canada: The Nichols Chemical Co., Ltd. • Montreal • Toronto • Vancouver**

J-M Uneepac® does it again!



"Very satisfactory sealing service against wide variety of fluids and pressures up to 5,500 psi"

says Black, Sivalls and Bryson, Inc. makers of BS&B Glycol Pump



Uneepac comes in two types. Shown here is design for flange widths up to ½" which is used in BS&B Glycol Pump. Large illustration above shows design for flange widths over ½".

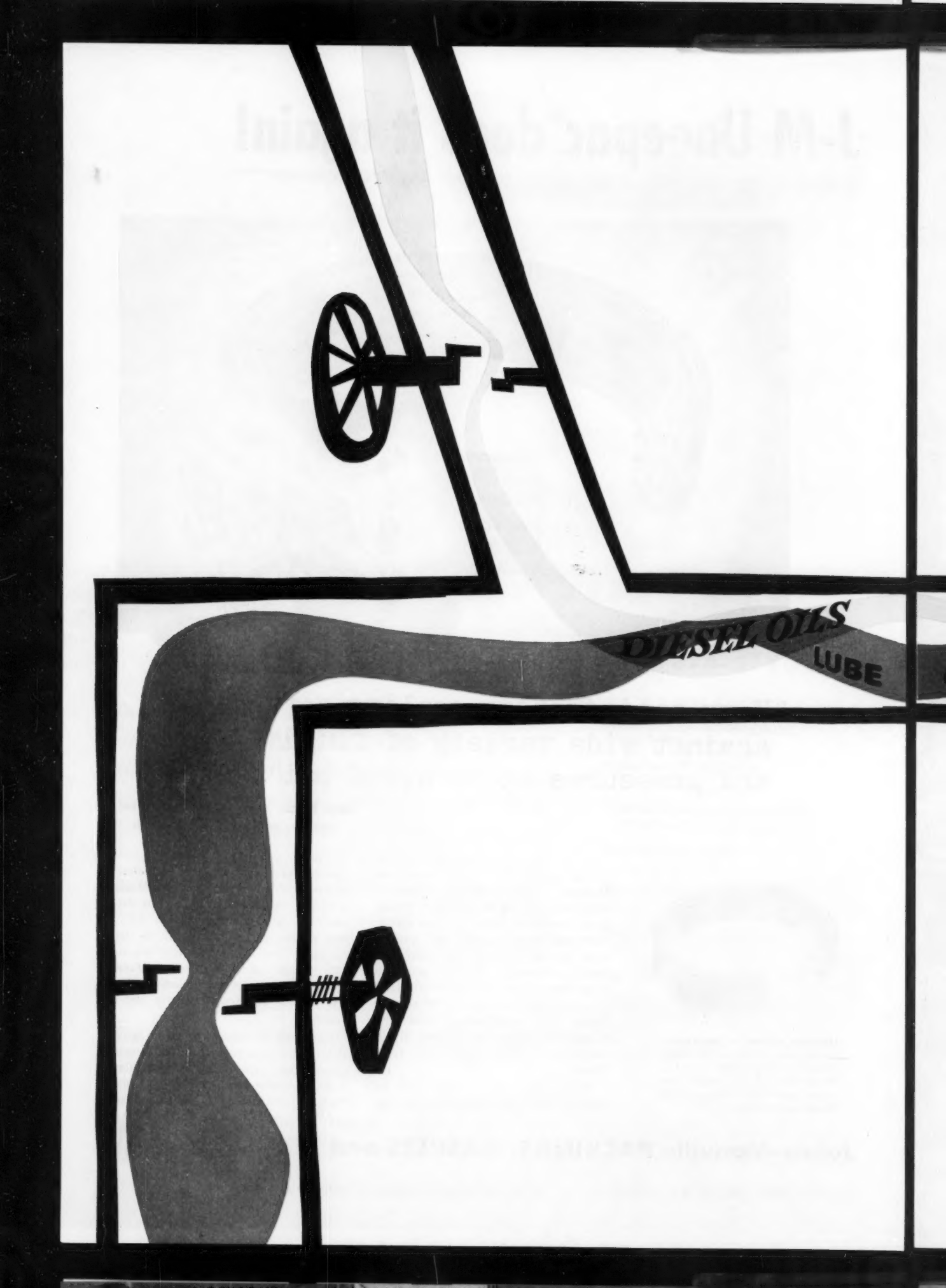
Chalk up another success story for Uneepac—Johns-Manville's automatic ring packing. In the BS&B Glycol Pump, fluids handled include triethylene glycol, diethylene glycol, gasoline, and various types of oils, alcohols and petroleum treating chemicals. Working pressures range from 125 psi to 5,500 psi with average operating pressures at 3,000 psi. Yet despite these rugged service conditions, Uneepac has delivered—in Black, Sivalls and Bryson's own words—"very satisfactory service."

Many other packing users have acclaimed J-M Uneepac for its long, trouble-free service. Each ring is a complete packing unit. Fewer rings are needed than ordinarily required and stuffing box size can be reduced to the minimum. Each ring centers itself automatically on the preceding ring to simplify installation. This exclusive design also permits fluid pressure to act upon each lip individually and protects lips from excessive gland pressure.

J-M Uneepac comes in a wide range of styles and sizes for many rod and plunger applications. For further information write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

For more data on advertised products, use Readers' Service Cards, last page.


DIESEL OILS
LUBE

REFINERY PRODUCTS FUNCTION BETTER

when you add versatile
Armour Duomeens®

There seems to be no end to the versatility of the Duomeens and their derivatives. That's why most of America's major refining companies are today using these oil-soluble, cationic chemicals as corrosion inhibitors in the refining process, as chemical intermediates for making various refinery products—and, of course, for direct use as special additives in the finished products.

Nearly every refinery finished product is benefiting from one of the Duomeens or their derivatives: aviation gasolines, jet fuels, automobile gasolines, #2 fuel oils, diesel oils, lube oils and a variety of greases—to name a few.

The Duomeens function in many ways in the finished products. They are used as outstanding corrosion inhibitors in gasolines, lube oils and greases. They have few equals when used as sludge inhibitors in various fuels and oils. Then too, many oil companies are putting Duomeens into hi-pressure oils and greases where they act as pressure lubricants and oiliness agents. The Duomeens also function as de-icers in gasolines.

The Duomeens are dipolar . . . $R(NH)CH_2CH_2CH_2(NH_2)$ . . . organic surface active agents. They have adsorption characteristics which enable them to form organophilic or hydrophobic films on metal surfaces when used alone—or when reacted with organic or inorganic acids. Reacted, they give varying degrees of water and/or oil solubility, depending on the requirement.

Chemical and Physical Properties

	Duomeen C		Duomeen T		Duomeen S	
	Min.	Max.	Min.	Max.	Min.	Max.
Iodine Value	5	15	32	50	50	
% Active Duomeen	83		83		83	
Primary Amine	35	45	35	45	35	45
Secondary Amine	38		38		38	
Moisture %		1		1		1
Color—FAC		19		19		13
Melting Point 25°C	20	24	38	43	33	38
Combining Weight	304	311	377	386	378	387
Appearance @ 25°C	Liquid		Soft Paste		Heavy Liquid	
Specific Gravity @ 25°C	0.836		0.841		0.846	
Viscosity @ 25°C	10 cps.		880 cps.		70 cps.	
Viscosity @ 30°C	—		70 cps.		40 cps.	
Viscosity @ 35°C	—		10 cps.		10 cps.	

These chemicals have passed industry-wide specification tests such as the steam turbine test, the salt water spray test and others.

Don't overlook the adaptability of the Armeens®. These monopolar . . . $R(NH_2)$ . . . high molecular weight aliphatic amines have many of the same properties that make the Duomeens so popular with refineries.

Armour pioneered the use of fatty amines and diamines in refinery applications. The technical knowledge gained through many years' research and development is now available to you. Our trained staff will help you utilize the right additive for your products, or for your special situation. There is a Duomeen or Armeen—or perhaps one of their derivatives—specifically designed to solve your problem.

ARMOUR CHEMICAL DIVISION

©Armour and Company • Chicago 9, Illinois

Leader in Progressive Fatty Acid Chemistry

SEND FOR PRODUCT SAMPLES, INFORMATION AND FREE "SLIDE RULE" CALCULATOR

☐ Duomeen Booklet PR12

Samples of _____
(fill in chemical desired)

Application information on _____

☐ Chemical additive "Slide Rule" Calculator

Name _____

Title _____

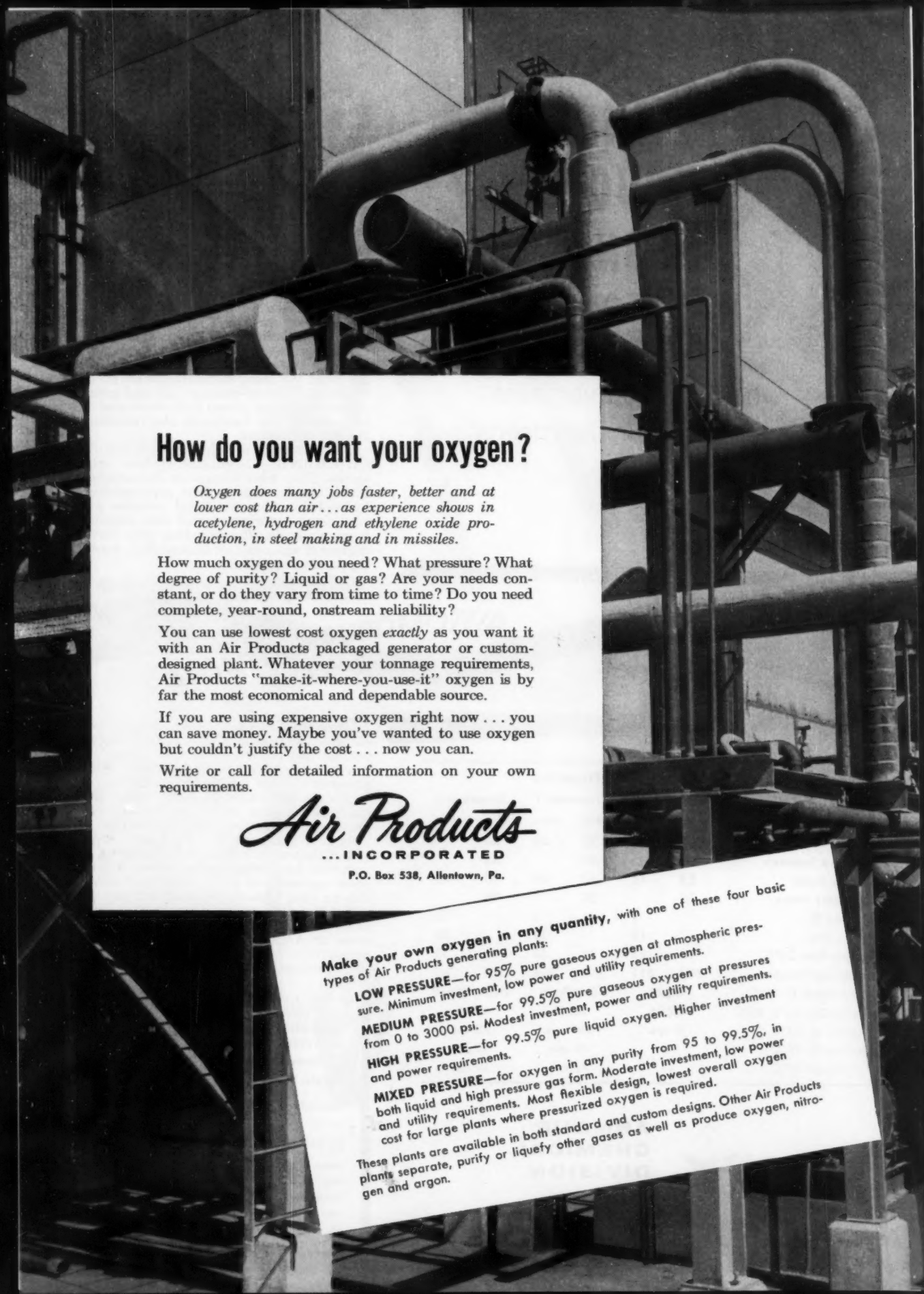
Company _____

Address _____

City _____

(Offer limited to North American Continent)

Armour Chemical Division • 1355 W. 31st St. • Chicago 9, Ill.



How do you want your oxygen?

Oxygen does many jobs faster, better and at lower cost than air . . . as experience shows in acetylene, hydrogen and ethylene oxide production, in steel making and in missiles.

How much oxygen do you need? What pressure? What degree of purity? Liquid or gas? Are your needs constant, or do they vary from time to time? Do you need complete, year-round, onstream reliability?

You can use lowest cost oxygen *exactly* as you want it with an Air Products packaged generator or custom-designed plant. Whatever your tonnage requirements, Air Products "make-it-where-you-use-it" oxygen is by far the most economical and dependable source.

If you are using expensive oxygen right now . . . you can save money. Maybe you've wanted to use oxygen but couldn't justify the cost . . . now you can.

Write or call for detailed information on your own requirements.

Air Products
...INCORPORATED

P.O. Box 538, Allentown, Pa.

Make your own oxygen in any quantity, with one of these four basic types of Air Products generating plants:

LOW PRESSURE—for 95% pure gaseous oxygen at atmospheric pressure. Minimum investment, low power and utility requirements.

MEDIUM PRESSURE—for 99.5% pure gaseous oxygen at pressures from 0 to 3000 psi. Modest investment, power and utility requirements.

HIGH PRESSURE—for 99.5% pure liquid oxygen. Higher investment and power requirements.

MIXED PRESSURE—for oxygen in any purity from 95 to 99.5%, in both liquid and high pressure gas form. Moderate investment, low power and utility requirements. Most flexible design, lowest overall oxygen cost for large plants where pressurized oxygen is required.

These plants are available in both standard and custom designs. Other Air Products plants separate, purify or liquefy other gases as well as produce oxygen, nitrogen and argon.

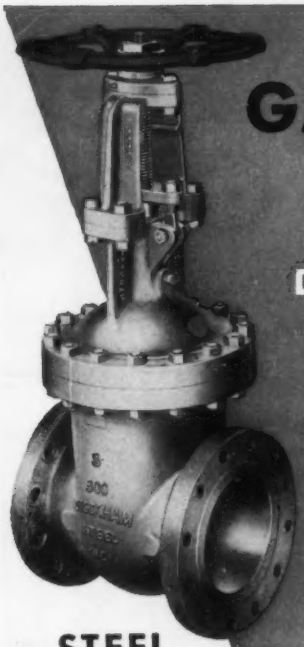
GATE • GLOBE • PLUG
ANGLE • CHECK

Dependable Valves For Your General-Purpose Needs

Stockham Cast Steel Valves

- Scientific Design
- Rugged Construction
- Precision Finish
- Carbon Steel and Special Alloys
- Wide Selection of Trims

Distributed by stocking valve distributors throughout the United States



STEEL GATE VALVES

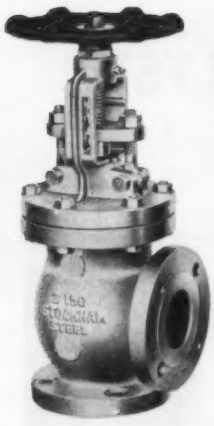
Flanged Ends
Screwed Ends
Butt Weld Ends

STEEL GLOBE VALVES

WEDGEPLUG
NON-LUBRICATED
STEEL PLUG VALVES

LIFTS, TURNS, AND RESEATS IN ONE OPERATION

Wrench Operated
•
Handwheel Operated
•
Worm Gear Operated



STEEL SWING CHECK VALVES

STEEL ANGLE VALVES

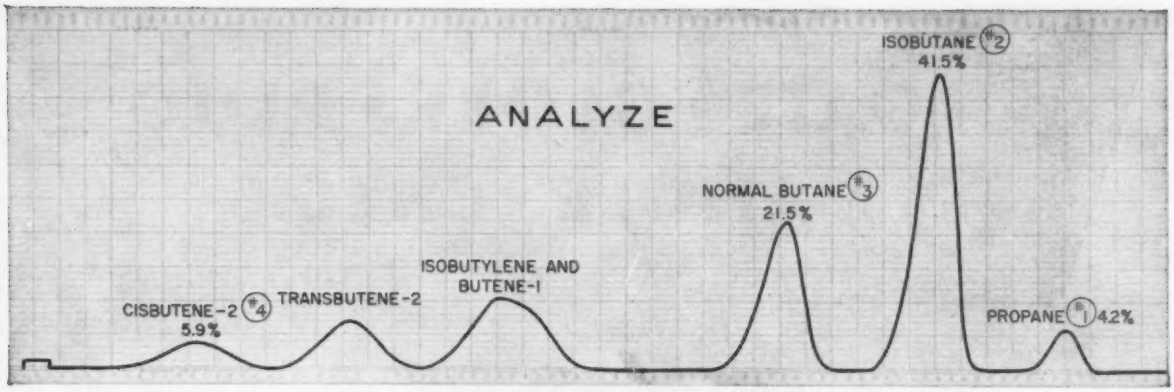
STOCKHAM VALVES STEEL

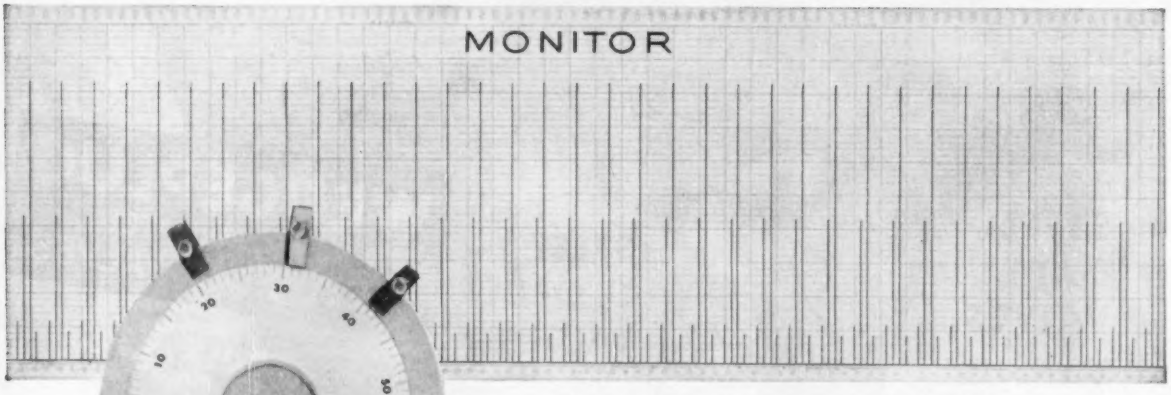
Write for "Stockham" and "Wedgeplug" Catalogs

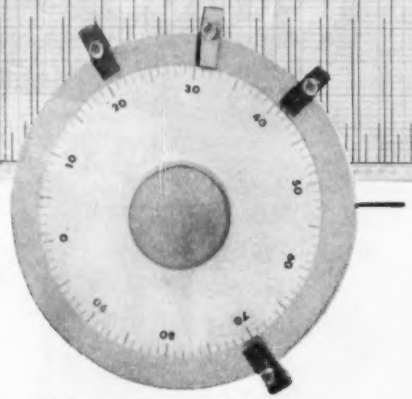
STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

Stockham Warehouses—
Chicago, Houston, Los Angeles and Philadelphia

For more data on advertised products, use Readers' Service Cards, last page.







Top: Model 184 fractogram in one mode of chart presentation shows quantitative analysis of components from typical refinery stream.

Bottom: Percent concentration of four preselected components from fractogram above is directly shown on bar chart.

Left: Timing dial of programmer is designed for fast set-up and calibration, also to indicate peaks.

A New Instrument for

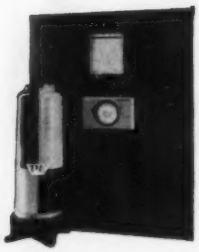
AUTOMATIC PLANT STREAM ANALYSIS BY GAS CHROMATOGRAPHY

After more than a year of field tests with ten leading oil and chemical companies, a new process vapor fractometer is now commercially available for multi-component analysis and monitoring of process streams.

The Model 184 is simple, versatile and reliable. Long term accuracy under plant conditions was a prime design consideration. Reproducibility is unequaled. Every safety feature has been incorporated.

Thanks to its in-plant evaluation by top instrumentation and process control engineers, the new P-E Model 184 can be put on stream with confidence—next year's afterthoughts are already built in.

For more information write us at 880 Main Avenue, Norwalk, Conn.



Model 184 consists of analyzer unit in explosion-proof housing, panel mounted programming and recording units. Instrument monitors up to four components directly on bar chart.

INSTRUMENT DIVISION

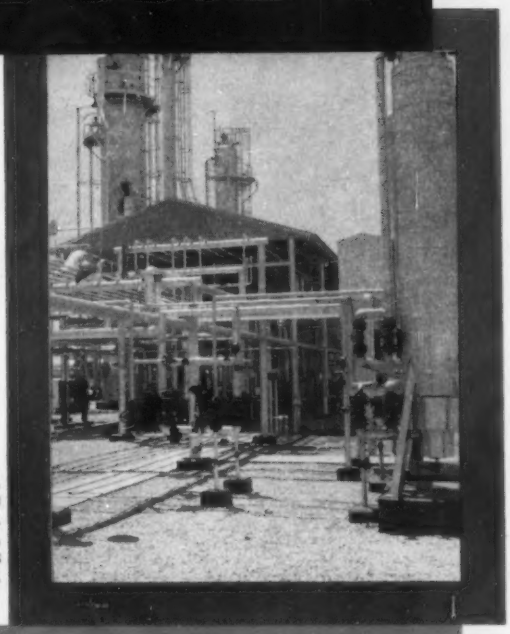
Perkin-Elmer *Corporation*

NORWALK, CONNECTICUT

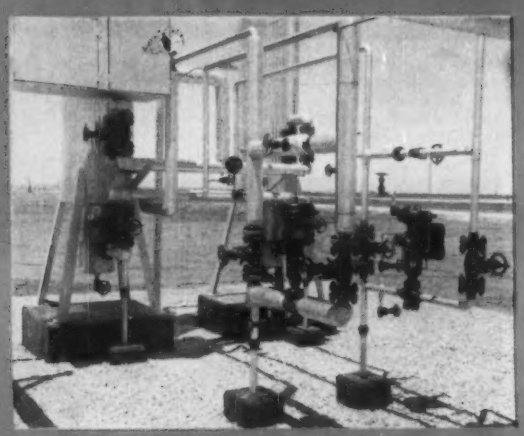
For more data on advertised products, use Readers' Service Cards, last page.

start using orbit

forged steel asa class valves in your process area from formation to finished product



Right foreground, propane dehydrators. In background, plant process pump area.



ORBIT FORGED STEEL ASA CLASS VALVES IN SERVICE AT A KANSAS GASOLINE PLANT.

Propane dehydrators.

Product loadout pumps and storage area.

advantages

No voids or cavities in body or bonnet where pressures can build up from trapped fluids when valve is either in open or closed position.

Non-lubricated, positive, friction-free closure which eliminates possibility of product contamination from valve lubricants.

Rising stem.

Adjustable, pliable stem packing.

All forged steel, vapor-tight construction.

ORBIT ASA CLASS VALVES are available in Carbon or Stainless Trim. Full Round Opening Sizes 1" thru 4". Ratings: 300 lbs. thru 2500 lbs. Flanged or Screw Ends. Venturi Opening Sizes 2" thru 6". Ratings: 150 lbs. thru 2500 lbs. Flanged End Only.

AVAILABLE THRU YOUR FAVORITE OIL FIELD SUPPLY STORE OR REFINERY SUPPLY HOUSE

ORBIT VALVES®

ORBIT VALVE COMPANY

BOX 699, LUther 4-4761, TWX TU 925 TULSA, OKLAHOMA

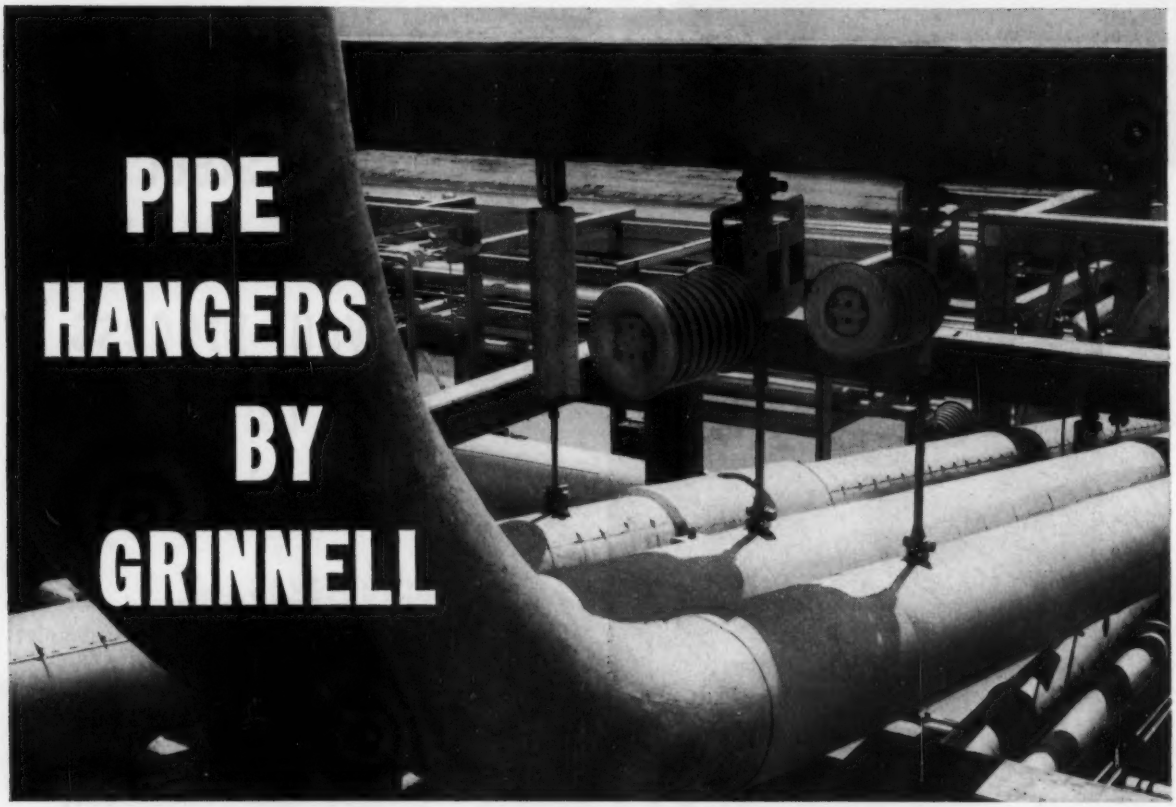
WAREHOUSES: HOUSTON, TEXAS, 407 Velasco, CApitol 8-6623, TWX HO 115; ODESSA, TEXAS, 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8041; EDMONTON, ALBERTA, CANADA, 7119-104th Street, Phone 391-283

WEST COAST REPRESENTATIVE: Fred P. Koenig Company, Long Beach, Calif., 3815 Atlantic Avenue, GArfield 4-3834

CANADIAN REPRESENTATIVE: T. R. Pickford & Company, Ltd., Calgary, Alberta, 536 8th Avenue West, Phone 2-7371

EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236

At Tidewater's new Delaware Refinery...



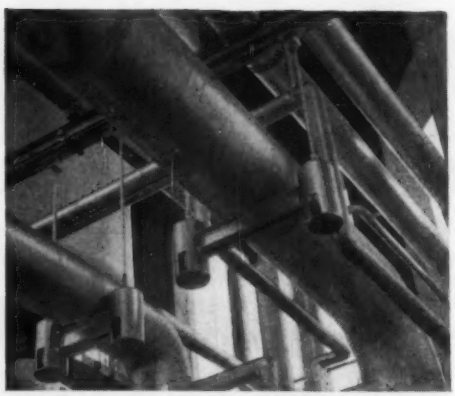
Tidewater Oil Company's new ultramodern $200-million, 5000-acre refinery, south of Wilmington, is the largest ever constructed at one time. Capable of processing 130,000 barrels of crude oil daily, the Delaware Refinery boasts eleven major processing units, including six of world-record size.

Pipe suspension problems, too, were bigger and more challenging at this record-breaking refinery. That's why Tidewater turned to Grinnell, America's #1 supplier of pipe hangers and supports.

A volume producer of pipe hangers, Grinnell backs up its high capacity and diversification with an efficient coast-to-coast network of warehouses and jobbers. Even complex hanger requirements very often can be met with hanger assemblies right off the shelf. This not only saves you time, but it can save you money, by cutting down on the number of special items which must be manufactured.

If you have a pipe suspension problem, you are invited to write: Grinnell Company, Inc., 282 West Exchange St., Providence, Rhode Island.

GRINNELL CONSTANT-SUPPORT HANGERS are engineered to maintain full safety factor. Constancy of support is mathematically perfect for all positions of travel. Note low headroom requirement. Load ranges from 30 lbs. to 32,260 lbs., with travels up to 12 inches.



GRINNELL VARIABLE SPRING HANGERS have precompression feature which assures operation of spring within its proper working range. Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes. Available in 21 sizes for loads ranging from 50 lbs. to 28,200 lbs.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.

avoid the hazards of carburetor icing with

GULF AGENT 178

...a better, less costly anti-stalling additive

Now you can stall-proof your modern volatile motor gasolines with a performance-proved additive at a lower cost than ever before.

FULLY PROVEN IN SERVICE—More than 25 billion miles of stall-free driving is proof of the effectiveness of Gulf Agent 178 in modern volatile motor gasolines.

INEXPENSIVE—Only 15 to 25 pounds of additive are required per thousand barrels of gasoline. No expensive storage space is required since you need so little of Gulf Agent 178.

EASY TO USE—Gulf Agent 178 is readily soluble in all petroleum products and can be blended easily at temperatures from minus 30° to plus 140° F. It is insoluble in water and can be used in conventional gasoline transfer systems with no danger of loss from water leaching.

RUST PROTECTION—Gulf Agent 178 gives you an extra benefit by providing corrosion protection at no extra cost. Rust prevention lengthens the life of distribution and storage facilities all the way from refinery to customer.

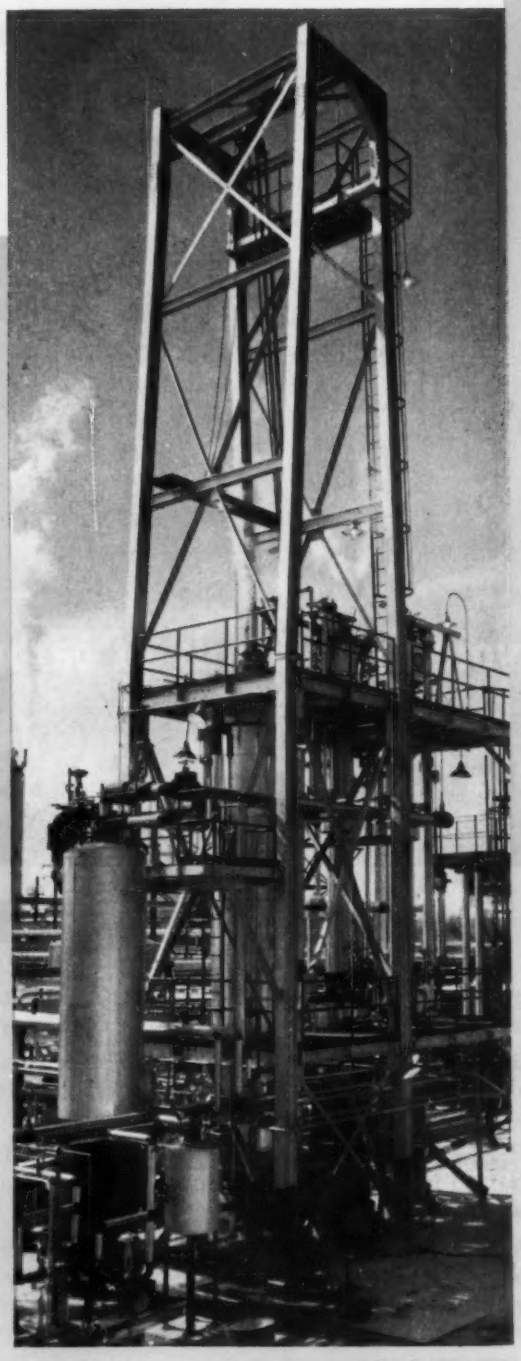
Let us show you how Gulf Agent 178 can improve your gasoline!

GULF

Petrochemicals Department
GULF OIL CORPORATION
Gulf Building, Pittsburgh 30, Pa.

QUALITY CHEMICALS
from
PETROLEUM

Southern Nitrogen's New Urea Plant on Stream...



When Southern Nitrogen's urea plant went on stream within recent months, it marked the successful completion of the second such plant in the U. S. which has been designed by Vulcan employing the Inventa-Vulcan process. The complete engineering of the plant—from initial design through startup —was performed by Vulcan Engineering Division, licensor of the Inventa process in the United States and Canada.

The new urea plant, with a production capacity of 30 tons per day, is a vital part of the facilities recently built by The Girdler Company for Southern Nitrogen Company, Inc.—a relatively new name in the chemical industry. Organized by a group of men possessing a wealth of industrial chemical processing experience, Southern Nitrogen was created to serve the important agricultural areas of the South. With a keen knowledge of market possibilities and production requirements, the management of Southern Nitrogen established their operations near Savannah, Georgia.

Using natural gas, water and air as the basic raw materials, the new Southern Nitrogen facilities produce anhydrous ammonia, prilled ammonium nitrate, ammonium nitrate solutions, urea solutions and mixtures of these. These products are used principally as fertilizers for the important cotton, tobacco and other agricultural crops of America's Southland.

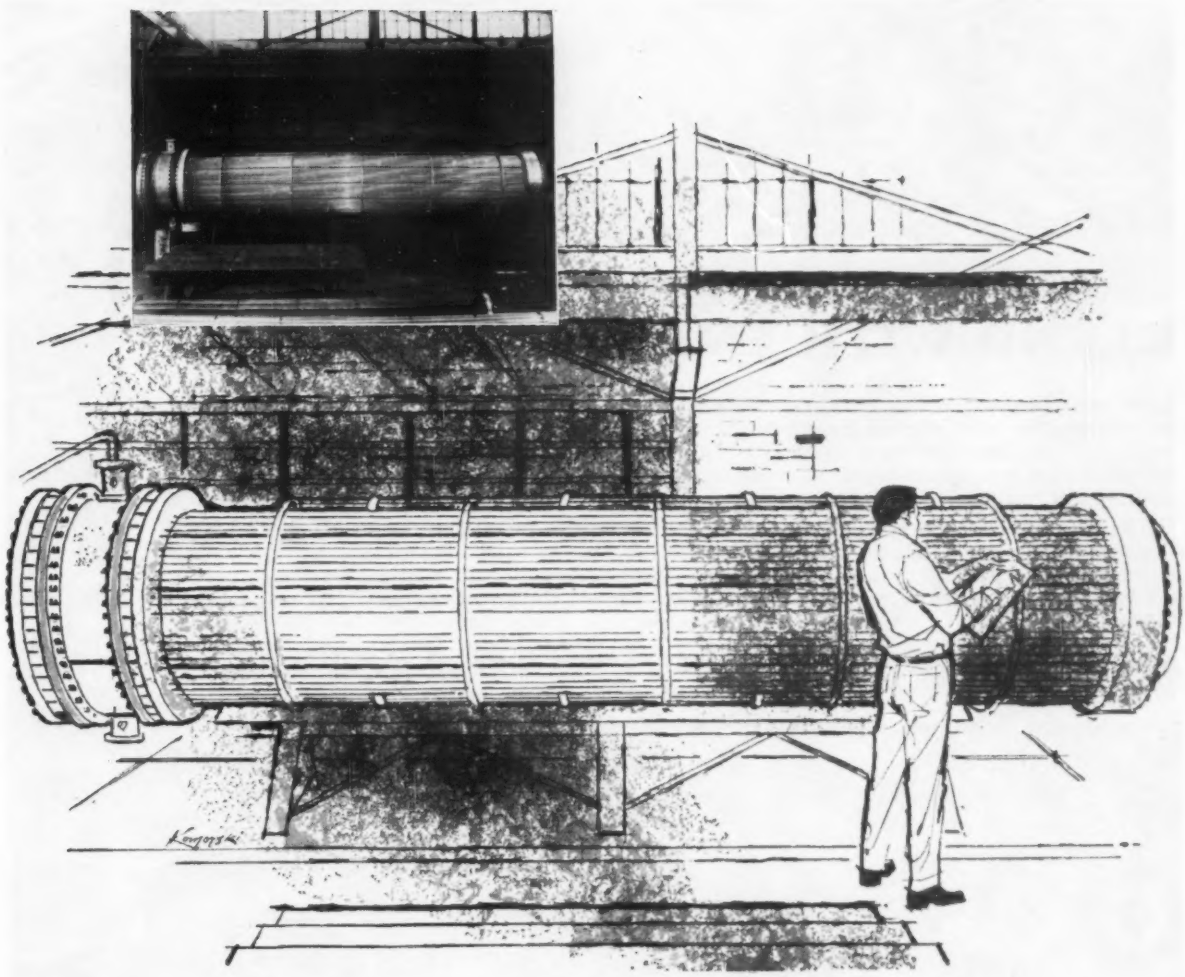
For this new venture the advantages of the Vulcan-designed urea plant were particularly appealing. Vulcan offered a modern process and sound engineering, both proven by actual performance using American equipment. The Inventa-Vulcan process features ease and reliability of operation, producing high purity urea solution with minimum plant investment, operating and maintenance costs.

VULCAN ENGINEERING DIVISION

VULCAN—Cincinnati, Inc. *General Offices and Plant,* CINCINNATI 2, OHIO

HOUSTON BOSTON CHARLOTTE, N. C. ST. LOUIS DENVER SAN FRANCISCO

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION



WESTERN SUPPLY SPECIFIED ALCOA ALUMINUM ALL THE WAY

on these 100% aluminum Dilution Coolers

The exchanger illustrated is one of a number furnished by Western Supply Company, Tulsa, Oklahoma, for a recent low-pressure polyethylene installation. They selected Alcoa® Aluminum for this service because of its protection of product color and stability, good heat transfer properties and corrosion resistance. For the same reasons, aluminum has also found wide use in ammonium nitrate cooling, sour gas treatment and many low temperature processes.

As Western Supply Company sums up the case for Alcoa Aluminum Heat Exchangers: "In our experience Alcoa Aluminum is a sound, low-cost solution to many of the problems encountered in petroleum refining, natural gasoline manufacturing, petrochemical and chemical processing."

If *you* have heat transfer problems affecting tubes or other components of either the channel or shell side, investigate aluminum! Aluminum offers corrosion resistance and good heat transfer properties at minimum cost, and has excellent physical properties at extremely low temperatures. Get details in the FREE BOOKLET, *Alcoa Aluminum Heat Exchanger Tubes*. Mail the coupon today!

NEW!
"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA
905-M Alcoa Building, Pittsburgh 19, Pa.

☐ Send me the FREE BOOKLET, Alcoa Aluminum Heat Exchanger Tubes.

☐ My heat exchanger problem is:

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

For more data on advertised products, use Readers' Service Cards, last page.

you can meet any lubrication specification if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

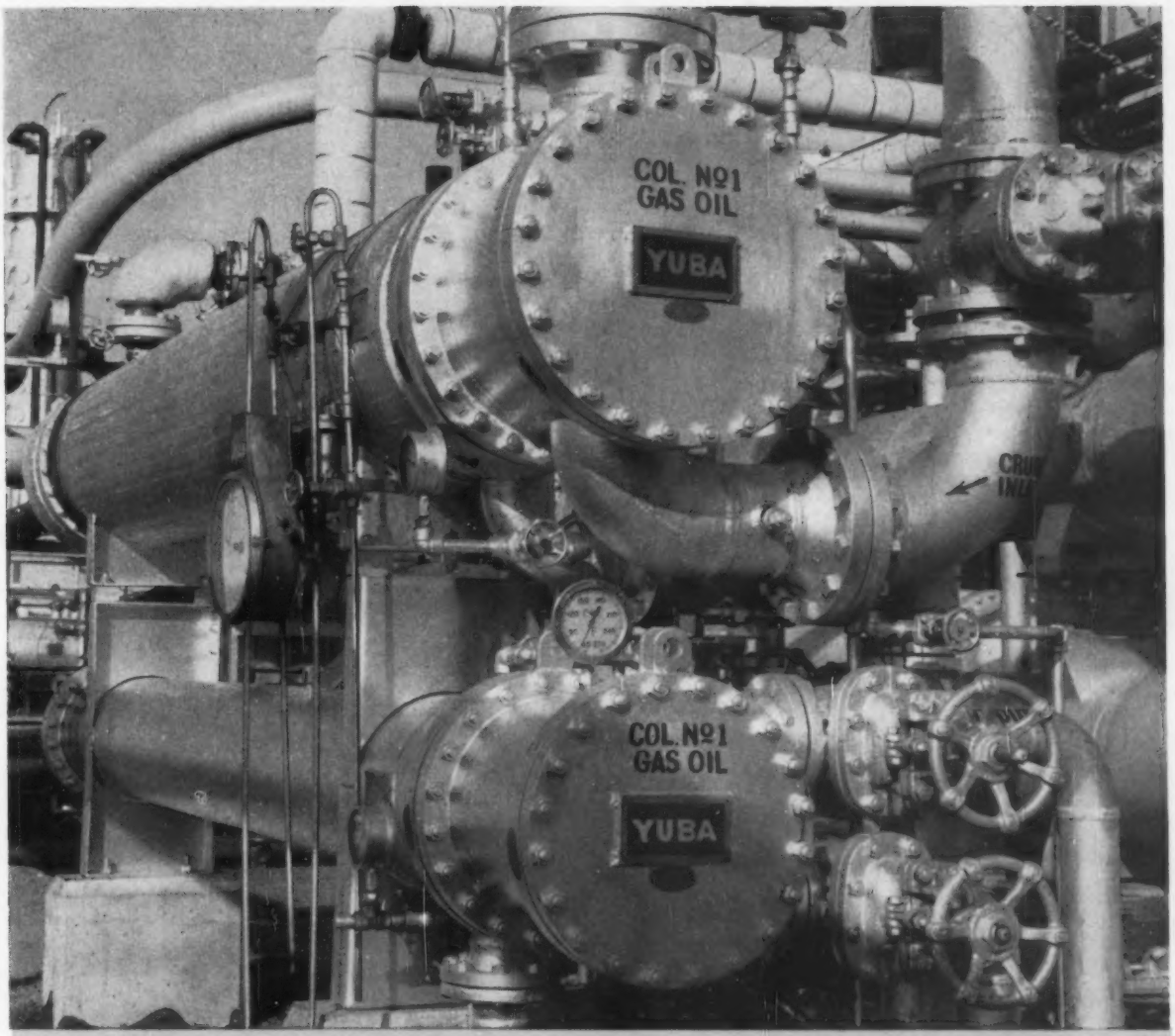
Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company today.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa



WHAT YUBA MEANS BY ENGINEERED HEAT EXCHANGERS

The manufacturer of heat exchangers is the sales engineer who services your account... the design engineer who designs the equipment and selects the materials... the welding engineer who specifies the welding procedures... the quality control engineer who sees that incoming materials meet specifications . . . that top-quality work is performed at every stage of manufacture... and the production control engineer who schedules your order so it will arrive the day you need it.

These competent people are to be found at YUBA's plants, in both the East and the West, where heat exchangers are made. Call YUBA for creative engineering and precision manufacturing.

YUBA

CONSOLIDATED INDUSTRIES, INC.

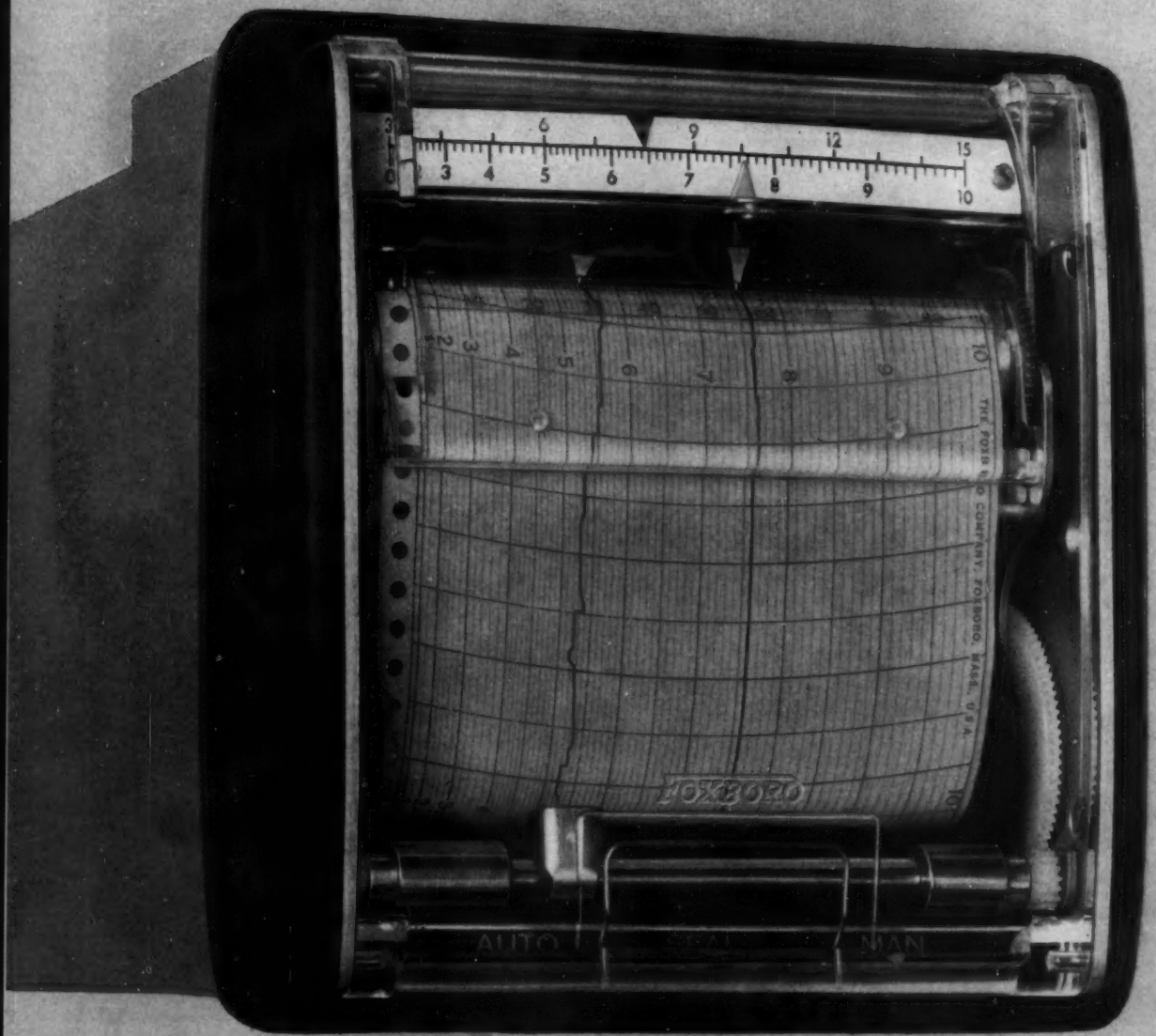
New York Sales Office: 530 Fifth Avenue
Branch Offices and Representatives in Principal Cities

Divisions Manufacturing Heat Exchangers

Yuba Heat Transfer Divison, Honesdale, Pa.
California Steel Products Division, Richmond, Calif.
Adsco Division, Buffalo, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

FOXBORO
adds new convenience features to CONSOTROL* Recording Control Stations



Shown actual size

*Reg. U. S. Pat. Off.

– further "operating ease" combined with accuracy – readability – top performance

3-pen recording, angle mounting, indicating tear-off bar . . . just a few of the new convenience features you'll find in Foxboro Consotrol Recorders and Recording Control Stations.

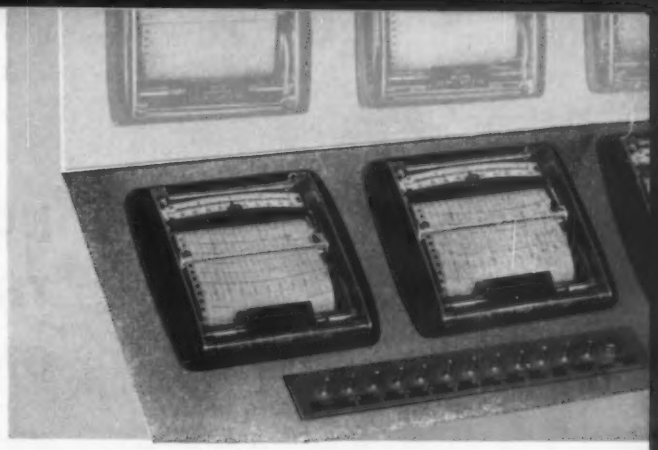
But these new operating benefits are only part of the story. Additional control functions are handled easily with Consotrol Instruments. Auto-Selector control — the control of related variables through a common valve is now possible with Consotrol small-case panel instrumentation, as is centralized control of batch processes.

With their new, exclusive operating conveniences and process control functions, Foxboro Consotrol Recording Control Stations, now, more than ever, provide you with superior centralized recording and control. You'll find they maintain the highest standards of precision and dependability — are the simplest to maintain.

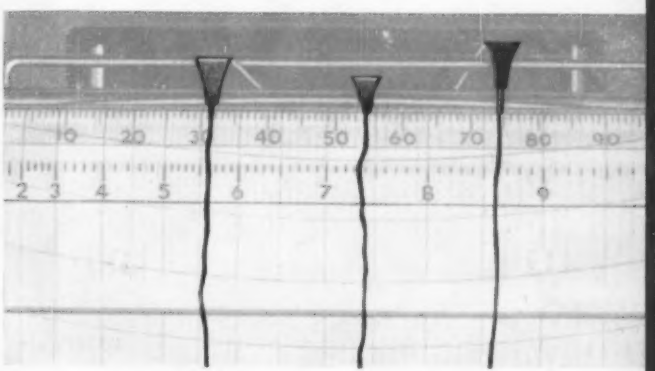
Write Foxboro for full details. Ask for Bulletin 13-18A. The Foxboro Company, 7412 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO

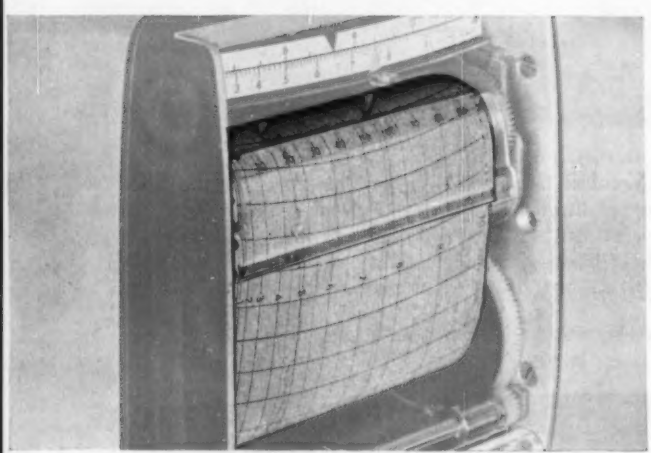
REG. U.S. PAT. OFF.



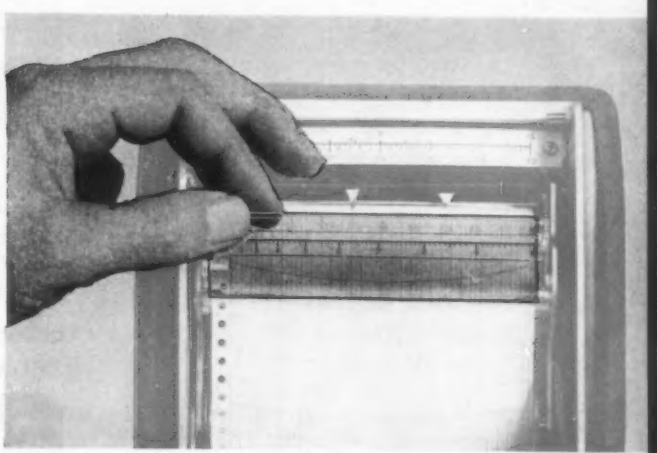
New – angle mounting Now you can panel-mount your Consotrol Recording Control Stations as much as 75° from the vertical, giving you more usable panel space closer to the floor. Operator can read lower instruments without stooping.



New – 3-pen recording 3 continuous records are simultaneously recorded on one chart, with this new Foxboro 3-pen recorder. Related measurements can be grouped for quick, easy comparison . . . valuable panel space is saved.



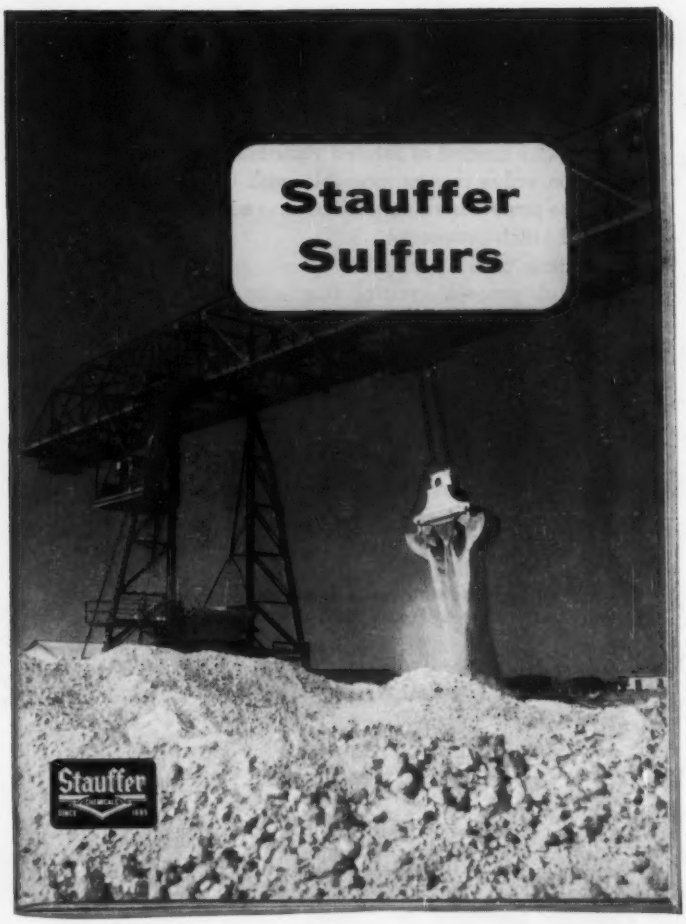
Full scale chart The Foxboro 4-inch Consotrol chart, with the same length scale as a 12-inch circular chart, travels vertically from the top. No sagging . . . no misalignment. Pen travels in same direction as circular-case recording pen.



New – indicating tear-off bar Ideal for multi-pen control stations and recorders, this new "see-through" plastic tear-off bar has indicating scales to read second and third variables. Scale colors match pen colors – makes following a process a cinch for the operator.

Sulfur

NOW READY...
THE NEWEST BOOK
ON THE OLDEST CHEMICAL



Stauffer Chemical Company — largest user and largest marketer of processed Sulfurs — has prepared a new, authoritative treatise and catalog on Sulfur. The history, preparation and uses, with a detailed description of Stauffer Sulfurs are included in a 52-page brochure with many illustrations and useful tables.

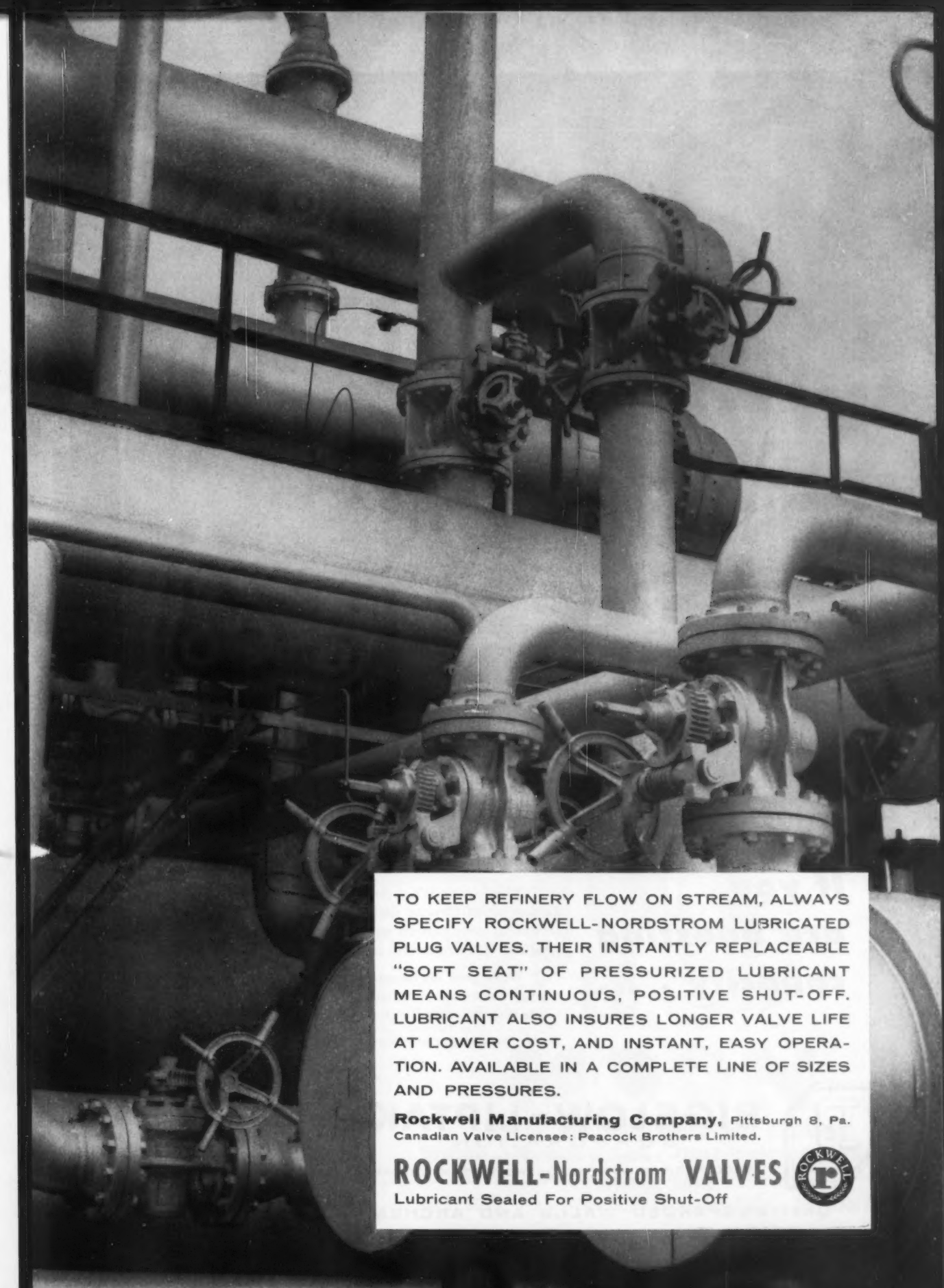
COPIES ON REQUEST; PLEASE WRITE ON YOUR LETTERHEAD.

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.
Prudential Plaza, Chicago 1, Ill.
636 California Street, San Francisco 8, Calif.

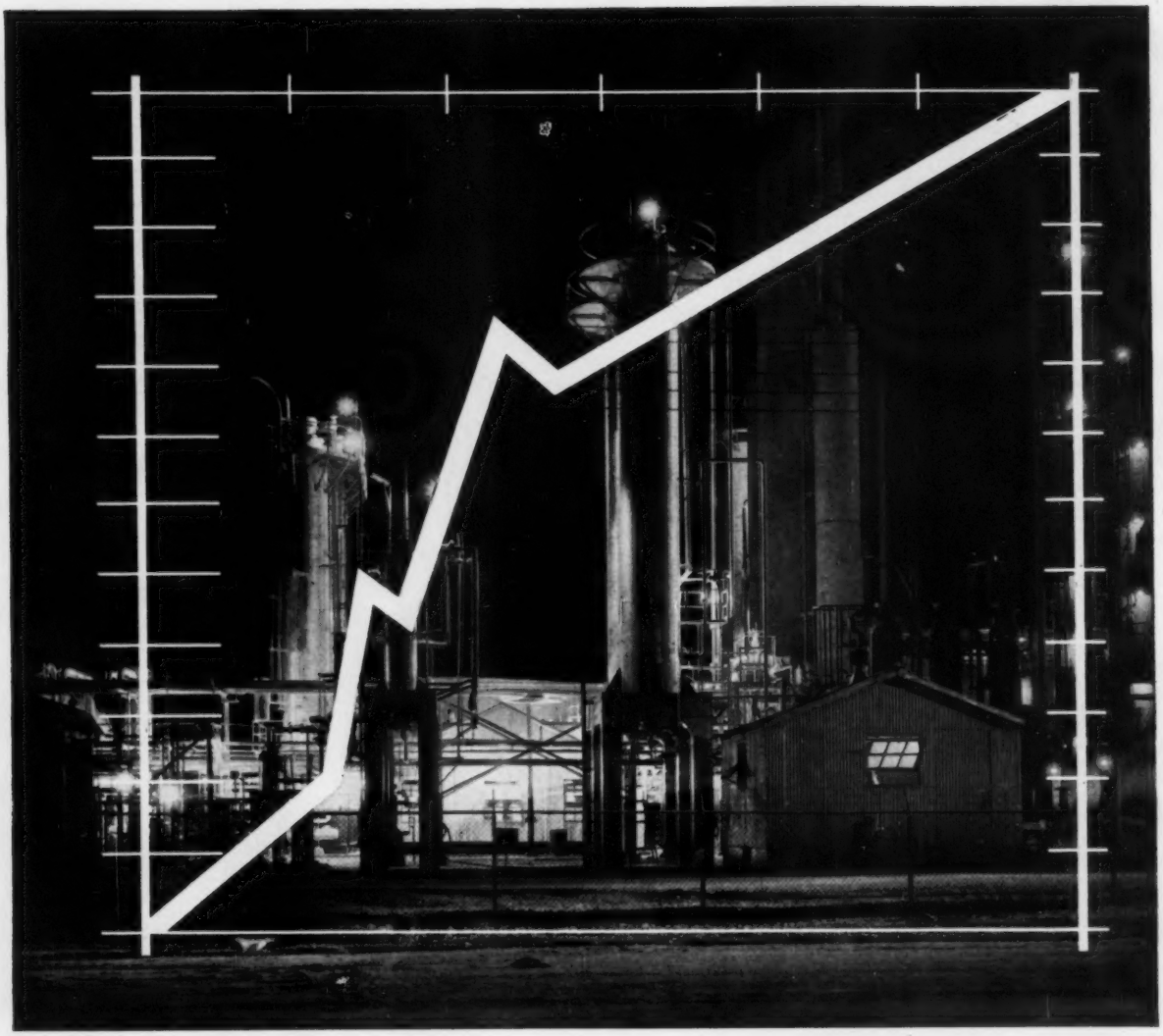
For more data on advertised products, use Readers' Service Cards, last page.



TO KEEP REFINERY FLOW ON STREAM, ALWAYS SPECIFY ROCKWELL-NORDSTROM LUBRICATED PLUG VALVES. THEIR INSTANTLY REPLACEABLE "SOFT SEAT" OF PRESSURIZED LUBRICANT MEANS CONTINUOUS, POSITIVE SHUT-OFF. LUBRICANT ALSO INSURES LONGER VALVE LIFE AT LOWER COST, AND INSTANT, EASY OPERATION. AVAILABLE IN A COMPLETE LINE OF SIZES AND PRESSURES.

Rockwell Manufacturing Company, Pittsburgh 8, Pa.
Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES
Lubricant Sealed For Positive Shut-Off



If you are boosting capacity . . .

New refining processes usually call for completely new equipment or drastic revamps of existing facilities.

That's why it's a good idea to get in touch with Bigelow-Liptak when furnace enclosures are being considered. Modernization of your present equipment will assure keeping pace with production demands and save money to boot.

When new enclosures are needed, B-L can design—furnish quality controlled materials—and erect. One source for everything—one responsibility for the job—saves you plenty in the long run.

Better investigate right now. Just write.

BIGELOW-LIPTAK
CORPORATION
AND BIGELOW-LIPTAK EXPORT CORPORATION
13300 PURITAN AVENUE, DETROIT 27, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

IN CANADA
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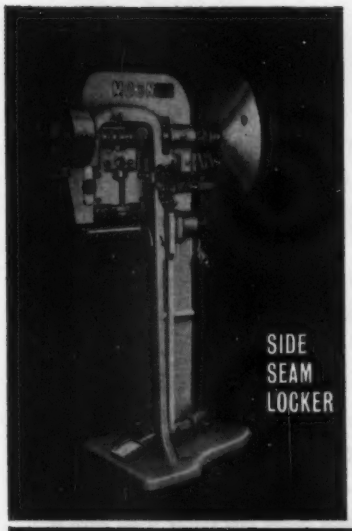
For more data on advertised products, use Readers' Service Cards, last page.

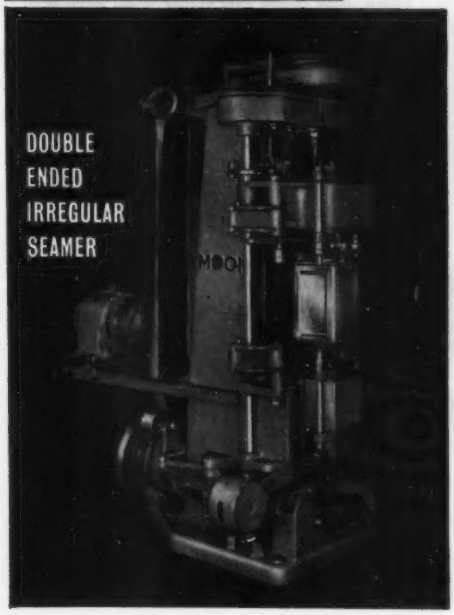
From Guillotine to Trimmer and Beader...

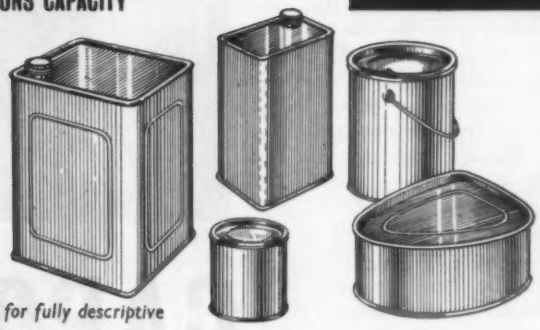
we make the whole range of machines for the manufacture of round and irregular tins of all sizes; for example, ham tins, paint tins, biscuit tins, oil tins, etc.

For many years we have supplied complete plants, comprising hand operated, semi-automatic and fully-automatic machinery for all sizes of tin boxes, steel drums and screw caps.



6-60 TONS CAPACITY





Write for fully descriptive literature to:—

MOON

MOON BROTHERS LIMITED, BEAUFORT ROAD, BIRKENHEAD.
TELEPHONE: BIRKENHEAD 1527/8/9. CABLES: "MOONBRO" BIRKENHEAD

LONDON OFFICE
ABBEY HOUSE, 2/8 VICTORIA ST., WESTMINSTER, S.W.1. TEL: ABBEY 1905

For more data on advertised products, use Readers' Service Cards, last page.

what's the secret

why is Caposite so strong?

It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

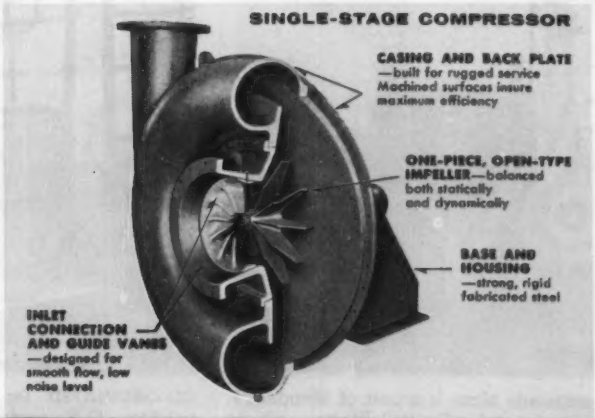
CAPOSITE Regd.

ASBESTOS INSULATION

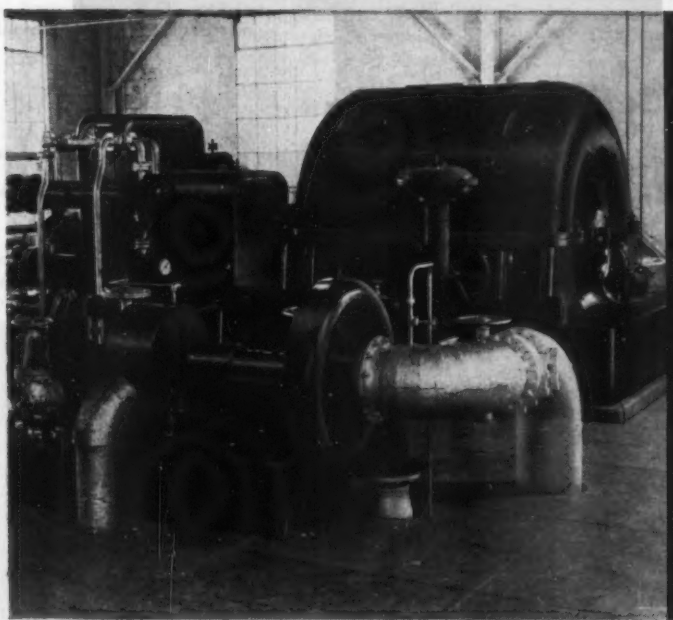
THE CAPE ASBESTOS COMPANY LIMITED, 114 & 116 PARK STREET, LONDON W1 Tel: Grosvenor 6022 Cables: Incorrupt London

Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois

TA 10643


SINGLE-STAGE COMPRESSOR
CASING AND BACK PLATE —built for rugged service Machined surfaces insure maximum efficiency
ONE-PIECE, OPEN-TYPE IMPELLER—balanced both statically and dynamically
BASE AND HOUSING —strong, rigid fabricated steel
INLET CONNECTION AND GUIDE VANES —designed for smooth flow, low noise level

Whether Single-stage or Multistage...



ELLIOTT CENTRIFUGAL COMPRESSORS

are both ruggedly designed for

NON-STOP PERFORMANCE

MULTISTAGE COMPRESSOR
EXTERNAL BEARINGS —sealed to prevent contact with gas
CASING AND DIAPHRAGMS—liberally proportioned and built for rugged service
DIFFUSERS—designed for smooth flow and efficiency
SHAFT THRUST COLLAR —Double kingsbury bearing absorbs axial loading and locates rotor
WELDED, CLOSED IMPELLERS—smooth continuous surfaces prevent build-up
LABYRINTH SEAL—effectively prevents interstage leakage

Elliott centrifugal compressors are available with inlet capacities up to approximately 150,000 cfm. For complete details, write Elliott Company, Compressor Department, Jeannette, Pa.

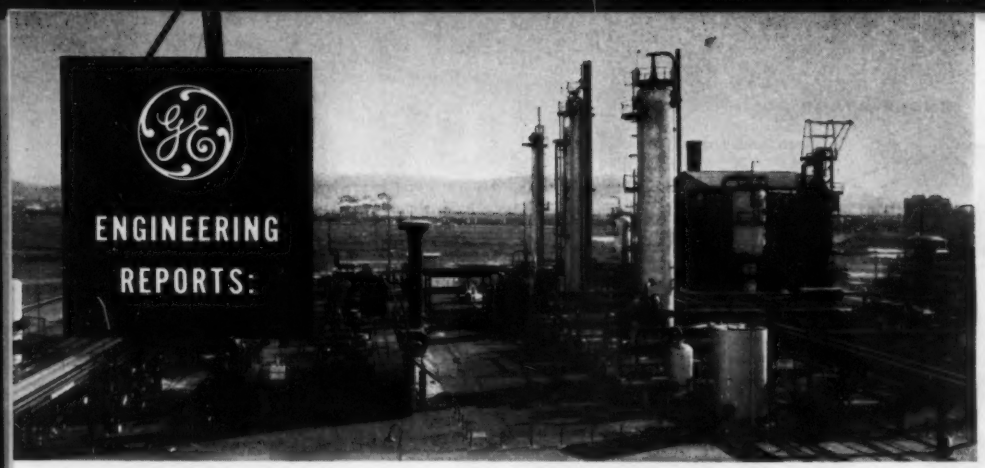
The Elliott centrifugal compressors in this installation photo are servicing a fluid catalytic cracking unit. They illustrate the flexibility of Elliott-engineered machines which are specifically designed to their applications.

The multistage machine in the background is the main air compressor, which compresses 61,000 icfm of atmospheric air to 29.4 psia in the process of lifting and regenerating the catalyst. It is driven by an Elliott 5000-hp multistage steam turbine. The single-stage compressor in the foreground is the control air compressor and it handles 3750 icfm of air from 28.9 to 33.2 psia. It is driven by an Elliott 116-hp turbine.

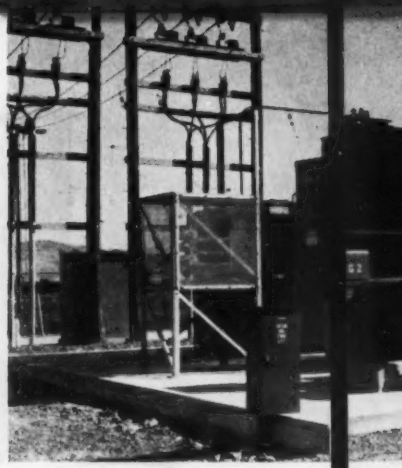
ELLIOTT Company

P7-6

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS



BUILT IN 14 MONTHS by The M. W. Kellogg Co., new ammonia plant is a unit of Standard's Richmond refinery, one of West's largest. All electric equipment is by General Electric, which also provided engineering service to help achieve fast start-up.

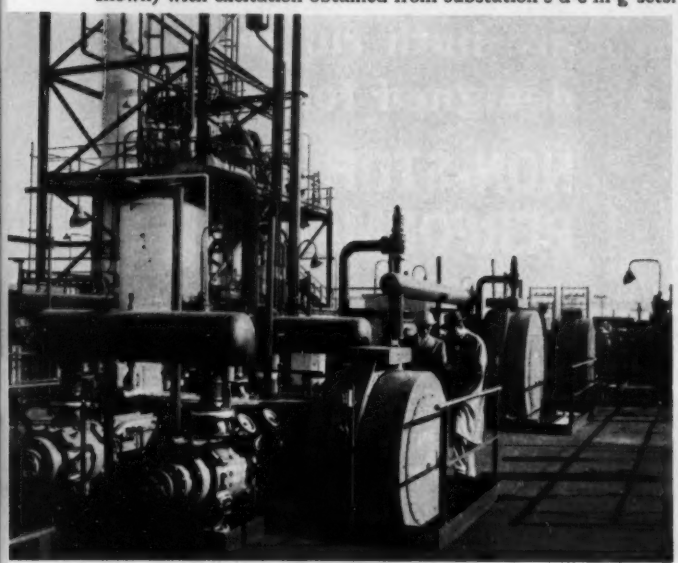


CO-ORDINATED for top reliability, G-E equipment in master substation for ammonia

At Standard's Richmond, Calif., refinery . . .

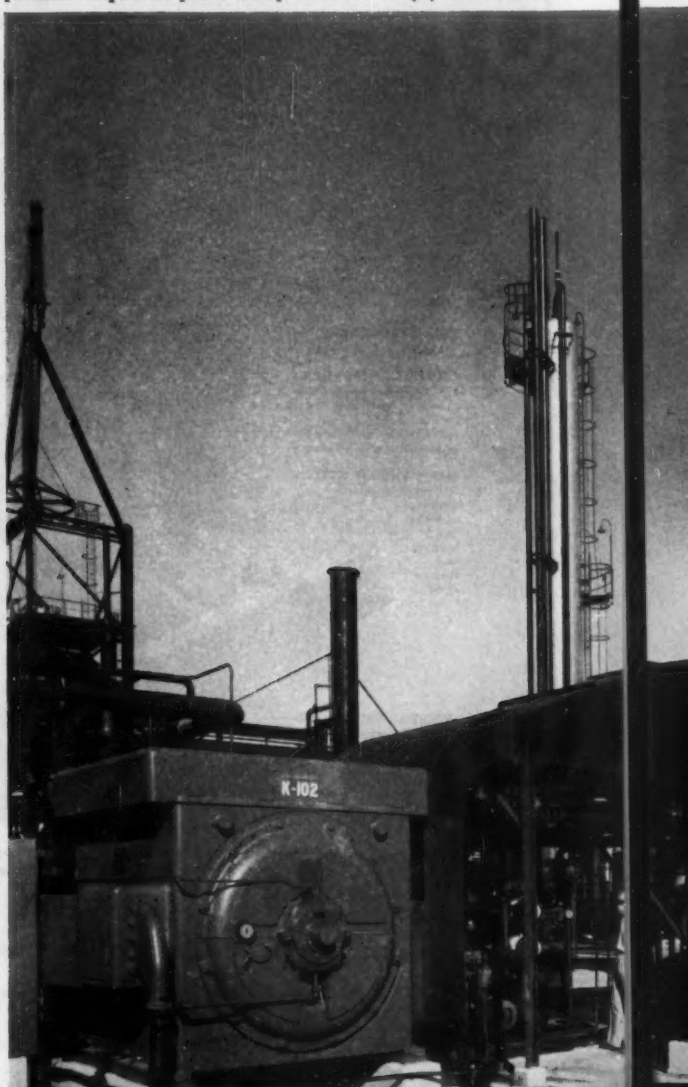
General Electric engineering services help

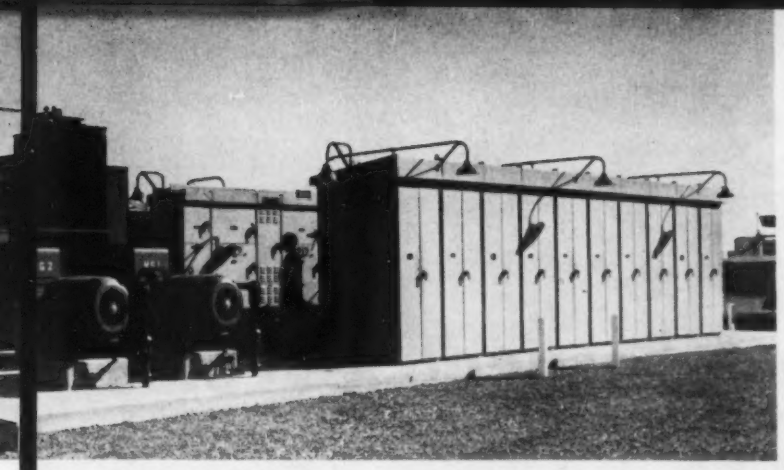
OUTDOOR-LOCATED on platform to drive compressors are 8 high-efficiency, enclosed, force-ventilated G-E synchronous motors (3 shown) with excitation obtained from substation's d-c m-g sets.



WEATHER-PROTECTED, 2 rugged 350-hp G-E induction motors drive cooling-water pumps. Other plant induction motors are either enclosed force-ventilated or explosion-proof, fan-cooled. ▼

PLANT'S BIGGEST, a 4000-hp 12,000-v totally enclosed force-ventilated G-E induction motor drives synthesis gas compressor. Explosion-proof 60-hp G-E motor (r.) drives blower





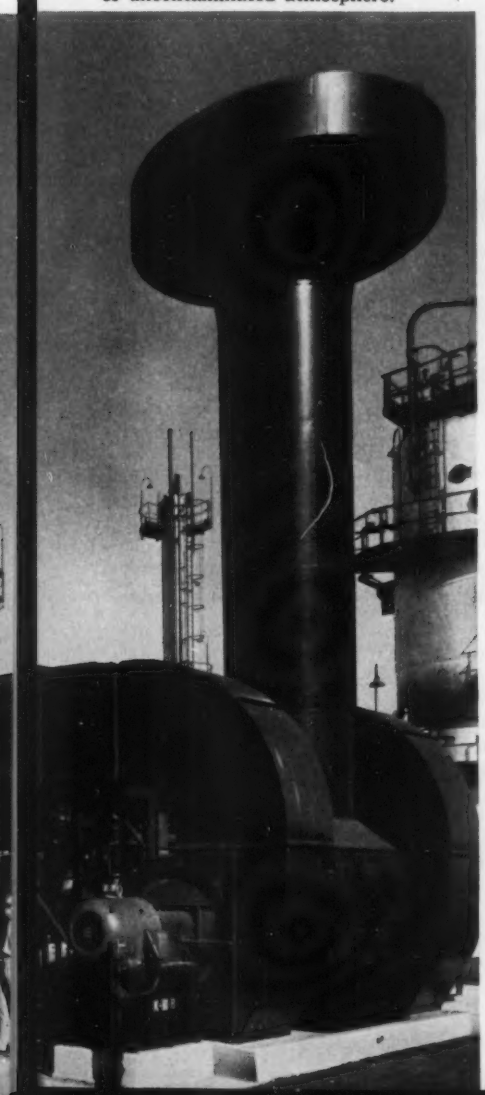
plant includes 5000-kva transformer, 17 units of 12-kv metal-clad switchgear, 2300-v Limitamp* motor starters, 480-v outdoor motor control centers, 2 outdoor motor-generator sets, and two 480-v transformers.

*Registered trade-mark of General Electric Co.

EASY MAINTENANCE of plant's G-E metal-clad switchgear is shown by workman removing vertical-lift, magne-blast circuit breaker for inspection.

speed opening of 300-ton/day ammonia plant

drawing clean air—via black ductwork and mushroom tower—from upper level of uncontaminated atmosphere.



General Electric power system, installed to meet rigid construction schedule, helps plant get fast start on profitable production

Standard Oil Company of California, Western Operations, Inc., recently added to its Richmond, California refinery—the largest west of the Rockies—a new $11 million ammonia plant designed, engineered and built by The M. W. Kellogg Co. The plant's capacity of approximately 300 tons per day of anhydrous and aqueous ammonia is shipped to nearby California Spray Chemical Corp., a subsidiary, for conversion into fertilizer.

GENERAL ELECTRIC supplied the new plant's electric equipment—compressor drives, auxiliary motors, and complete outdoor substation with co-ordinated components. In addition, General Electric engineering services helped both customer and designer get the new plant from the discussion stage to on-stream in only 14 months.

An example was the contribution of General Electric installation and field service engineers. By supervising the installation of the electric equipment as scheduled deliveries arrived, they helped reduce field installation costs, speed completion of construction schedules, and hasten start-up time. To Standard, this meant getting into production faster, and thereby, showing a return sooner on the large capital investment tied up in the plant.

IN ADDITION, the 17,000-kva block of power will be integrated into the existing plant system. General Electric application engineering services, working closely with Standard and Kellogg representatives, helped provide the electrical equipment co-ordination and integration necessary to meet the plant's process power requirements.

For *your* new chemical plant, too, General Electric offers a one-manufacturer source of quality electric equipment and valuable engineering services to help provide you and your process contractor with an efficient, co-ordinated electrical system. Early in your planning, contact your nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y.

662-49

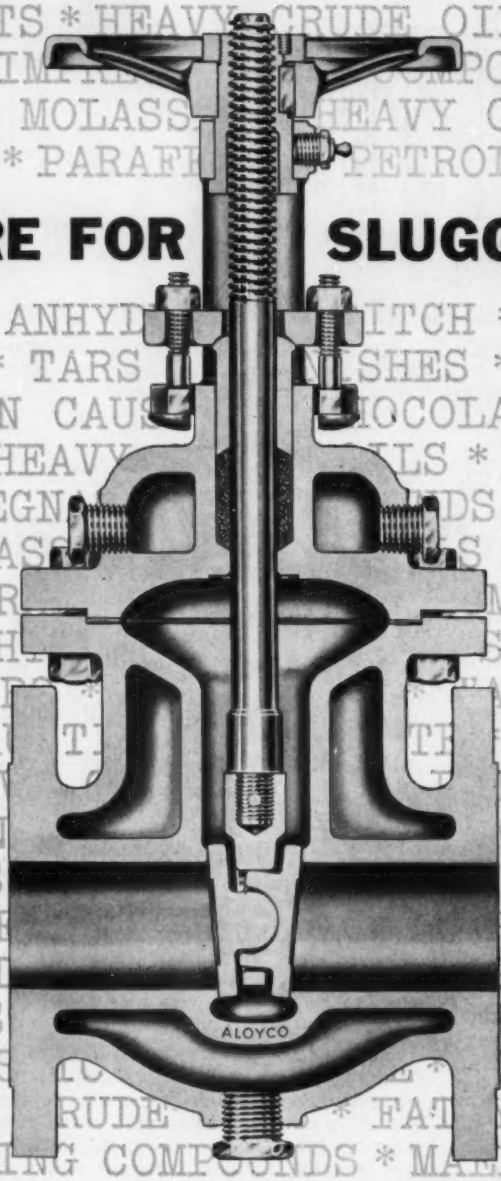
Engineered Electrical Systems for the Process Industries

GENERAL ELECTRIC

ASPHALT * MOLTEN CAUSTIC * CHOCOLATE * COAL TAR PRODUCTS * HEAVY CRUDE OILS * FATTY ACI DS * GUMS * IM POUNDS * MAELIC ANHYDRIDE * MOLASS HEAVY OILS * HYDROGE NATED OILS * PARAF PETROLEUM RESIDUES

SURE CURE FOR SLUGGISH FLUIDS

* PHTHALIC ANHYD ITCH * SOAPS * MOLT EN SULFUR * TARS ISHES * WAXES * ASPH ALT * MOLTEN CAUS OCOLATE * COAL TAR PRODUCTS * HEAVY ILS * FATTY ACIDS * GUMS * IMPREGN DS * MAELIC ANHY DRIDE * MOLAS S * HYDROGENATE D OILS * PAR M RESIDUES * P HTHALIC ANH SOAPS * MOLTEN SULFUR * TA AXES * ASPHALT * MOLTEN CA COAL TAR PRO DUCTS * HEA TTY ACIDS * GU MS * IMPREGN MAELIC ANHYDR IDE * MOLAS HYDROGENATED OILS * PARA RESIDUES * PHT HALIC ANHY PS * MOLTEN SU LFUR * TARS ES * ASPHALT * MOLTEN CAUS DAL TAR PRODU CTS * HEAVY RUDE FAT ACIDS * GUMS * IMPREGNATING COMPOUNDS * MAELIC ANHYDRIDE



COMPLETELY JACKETED ALOYCO VALVES

Aloyco Jacketed Valves are the surest way to keep slow moving corrosives flowing because they maintain higher temperatures than valves heated by other methods.

Jacketed valves are made in a variety of sizes and pressures and are furnished with convenient inlet and outlet holes for heating with steam or other media. They are available in 18 8S, 18 8SMO, Aloyco 20 and other analyses to specification.

The broad Aloyco Valve line includes Jacketed Gate (above) Globe and Check Valves, the first Jacketed Valves ever integrally cast in high alloys. One more indication of Aloyco's leadership in pattern making, foundry techniques and engineering skills. Long experience in these areas has made Aloyco the world's foremost specialist in Stainless Steel Valves.

Ask Aloyco's Corrosion Engineering Service to work with you on your valve problems. Alloy Steel Products Company, 1305 West Elizabeth Avenue, Linden, New Jersey. 7.12

ALLOY STEEL PRODUCTS COMPANY

DU PONT

Better Things for Better Living . . . through Chemistry

PETROLEUM ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON

TEFLON® tetrafluoroethylene resins

Parts made of TEFLON® show no wear in tests

tetrafluoroethylene resins

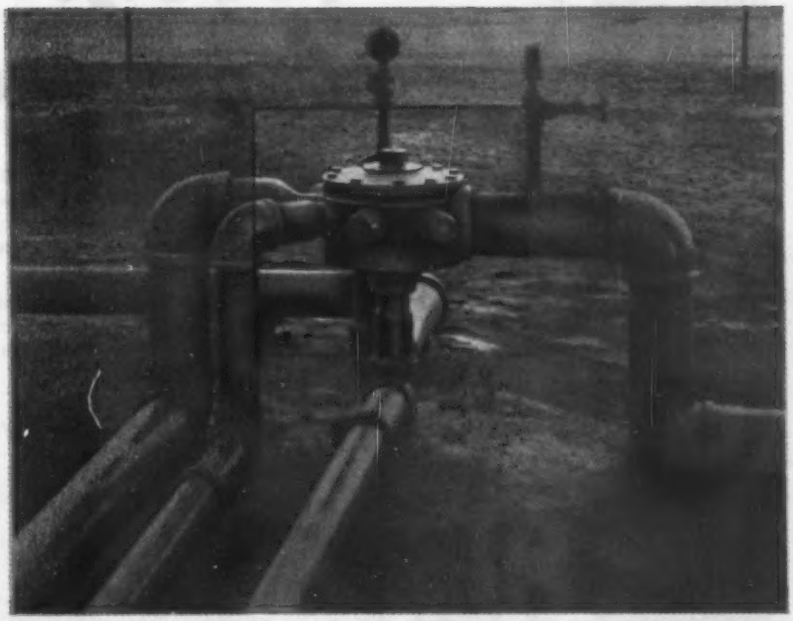
equivalent to 13 years' service

In tests at a six-well installation, a Win-Well valve with O-rings and bushings made of TEFLON 1 was automatically cycled at half-hour intervals for eight months – equivalent to 13 years' actual field operation. Inspection at the end of the period showed no wear or pitting of the parts made of TEFLON 1 tetrafluoroethylene resin. Valve performance was normal during the testing.

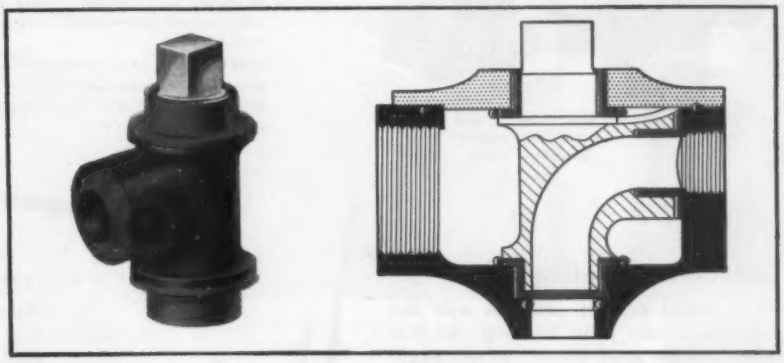
In designing the Win-Well valve, 33 different materials were tried, and TEFLON 1 was the only one which overcame all of the component design problems. Thanks to bushings of this low-friction material, the valve can be turned with virtually no torque, never requires lubrication and cannot "freeze" fast. Rated for working pressures of 600 psi, the valve operates without maintenance . . . does not leak even when handling corrosive and abrasive fluids.

Another of these petroleum valves, which has been operating successfully for over two years, handles a hot mixture of crude oil and high-pH water containing sharp sand. When examined after a 7-month test period, no change from the original dimensions was noted in the parts made of the TEFLON resin and the valve remained tight against leakage.

The remarkable chemical and physical properties of Du Pont TEFLON tetrafluoroethylene resins may help you solve your extracting and processing problems. Mail the coupon to obtain more facts on the versatile properties and end-uses of TEFLON resins.



FUNCTIONS of both valve and manifold are combined in this 7-way rotary valve. It employs O-rings and bushings made of TEFLON 1. Use of these parts prevents leakage and corrosion . . . eliminates need for lubrication. **(Above)** Typical oil-field installation. **(Below)** Control plug and diagram of valve. (Made by Win-Well Mfg. Co., Los Angeles, Calif.)



TEFLON®

is a registered trademark...

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the tetrafluoroethylene resins discussed herein. This registered trademark should not be used as an adjective to describe any product, nor should it be used in whole, or in part, as a trademark for a product of another concern.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 3612, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resins. I am interested in evaluating this material for_____

*Name*_____

*Company*_____ *Position*_____

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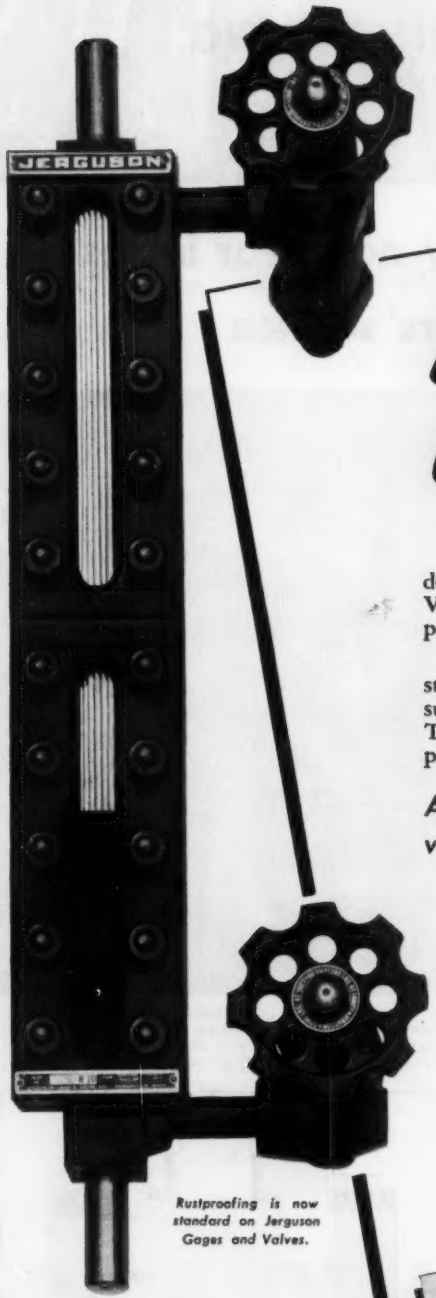

Rustproofing is now standard on Jerguson Gages and Valves.

Another JERGUSON first!

Rustproofed Gages and Valves

Here's a new development from Jerguson which has tremendous significance. Through a special process, Jerguson Gages and Valves are now rustproofed inside and out. No more painting or paint chipping. No more frozen connections due to rusted threads.

Jerguson Rustproofed Gages and Valves set entirely new standards of long-life and maintenance-free service. You get a far superior job initially, and you eliminate the problems of rusting. The rustproofed surface is an ideal base for those who prefer to paint gages and valves.

A complete line of liquid level gages, valves and specialties

Reflex and Transparent. With a variety of valves for all installations.

Large Chamber Gages. Minimize boiling and surging effect. Both Reflex and Transparent; also with non-frosting gage glass extension.

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Group G Instrument Piping Valves. Unions, nipples, reducers, elbows, tees, valve and bleed valve all combined in one space-saving unit.

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We've licked delivery problems with our new, double-size plant working two full shifts. You get good delivery on any Jerguson Gage or Valve . . . and off-the-shelf delivery on many standard units.

A valuable working tool

New Catalog No. 305 gives a high-spot condensation of the facts you need in specifying and ordering. Profusely illustrated with photographs, drawings, cross-sections, tables, sizes, pressure-temperature graphs and other useful engineering data. Send today for your copy.

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for cooling tower application...

There's MORE protection against humidity in Allis-Chalmers MOTORS

The ultimate in protection against high humidity — major cause of cooling tower motor failure — is provided tower builders and users in Allis-Chalmers TEFC motors. Here's why:

1. Moisture drainage — Drain plug can be removed to eliminate condensed moisture in the motor. (Particularly helpful in intermittent operations where condensation is more likely.)

2. Extra-insulated stator — Several applications of special insulating varnish plus repeated baking keep humidity out . . . give the long electrical life you need.

3. Weather-protected bearings — Rotating seal, turning in close running clearances, guards against entry of water.

Find out more about the "MORE" in Allis-Chalmers motors by contacting your nearby A-C sales office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

Outdoor Installation on jacket water-cooling units is ideal for Allis-Chalmers motors. Cast-iron frame and conduit box aren't affected by weather.

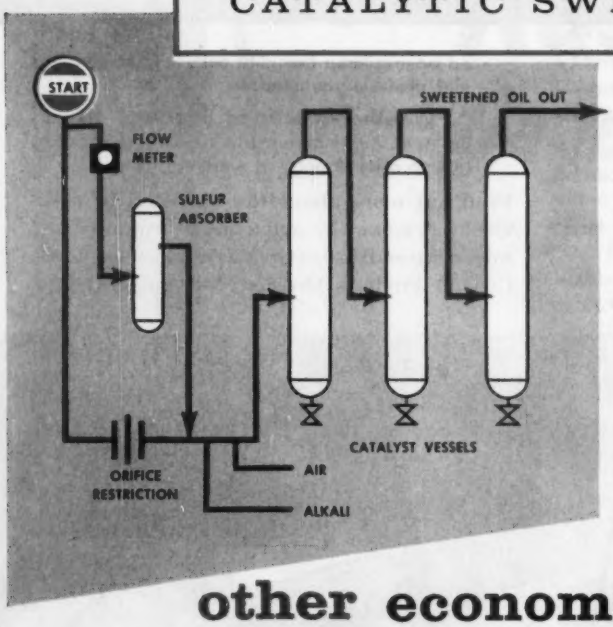
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5183

only 20% of the operating costs of conventional doctor treating!

PETRECO-BENDER
CATALYTIC SWEETENING PROCESS

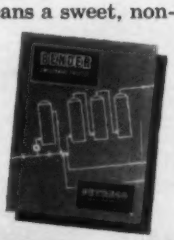


In the Petreco-Bender Process chemical costs are often 80% less than with conventional sweetening . . . the normal sulfur requirements are less than for doctor treating, and just enough alkali is needed to maintain a slightly alkaline distillate. Normal catalyst life is about 12 months before regeneration is required, and it can be done economically at the plant site.

. . . and there are other economic advantages:

- **No volume loss.**
- **Low Operating Cost.** Entire chemical cost of the Petreco-Bender Process is often less than cost of utilities alone in conventional sweetening.
- **No Regenerator Effluent to Dispose of; No Blackstrap; No Air Pollution.**
- **Automatic and Continuous Operation.**
- **A Better Product.** Use of less sulfur means a sweet, non-corrosive product.

FREE ILLUSTRATED BULLETIN
. . . Available to you on request.



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B-57-2

Newly designed
Type H Motor Control

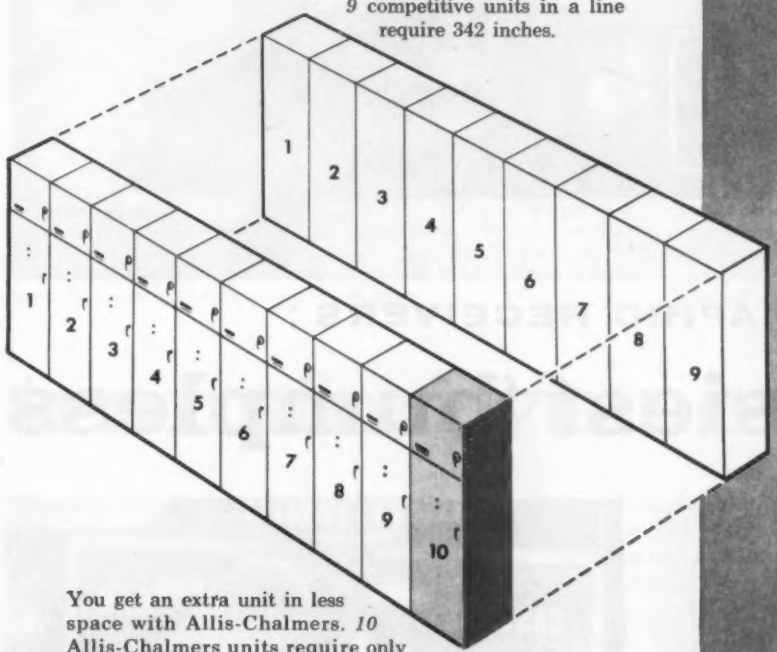
Saves valuable plant space

Newly designed Allis-Chalmers high voltage control units are only 34 inches wide. This means you can put 10 Allis-Chalmers cabinets in less space than required by 9 competitive 38-inch units. In addition, the narrower width means less space required for door swing. Result: You save a total of 2.36 sq ft of floor space per unit. On 10 units, this means a saving of 23.6 sq ft.

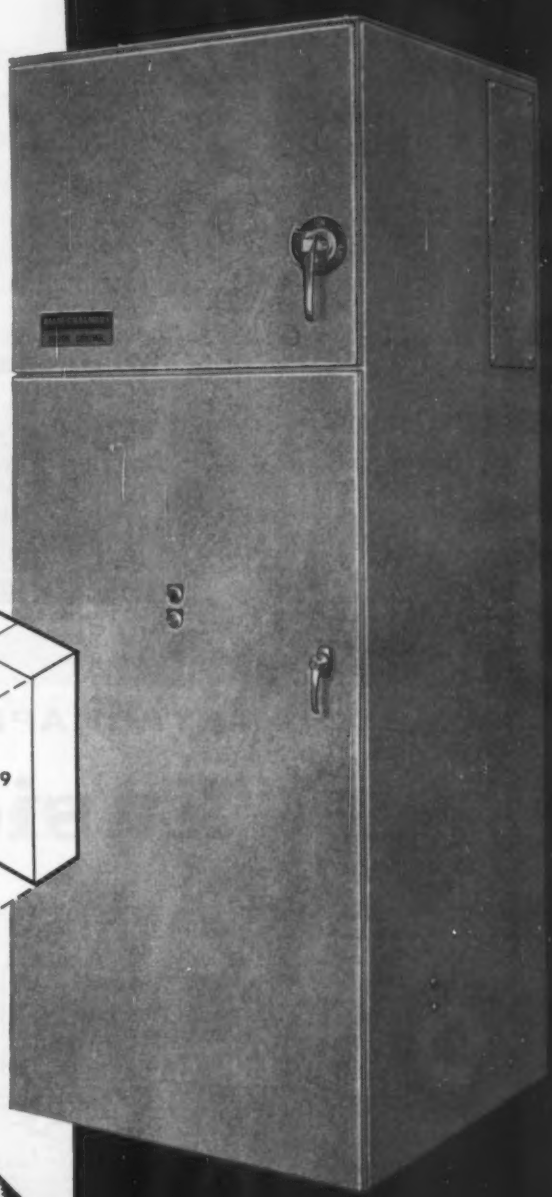
Smaller size is only one of many advantages in this new Allis-Chalmers design. You also get full-front access, more room for optional features, a completely tested unit, and the ultimate in protection for men and machines.

For more information on how this new control design can help you, call your nearest Allis-Chalmers representative, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

9 competitive units in a line require 342 inches.

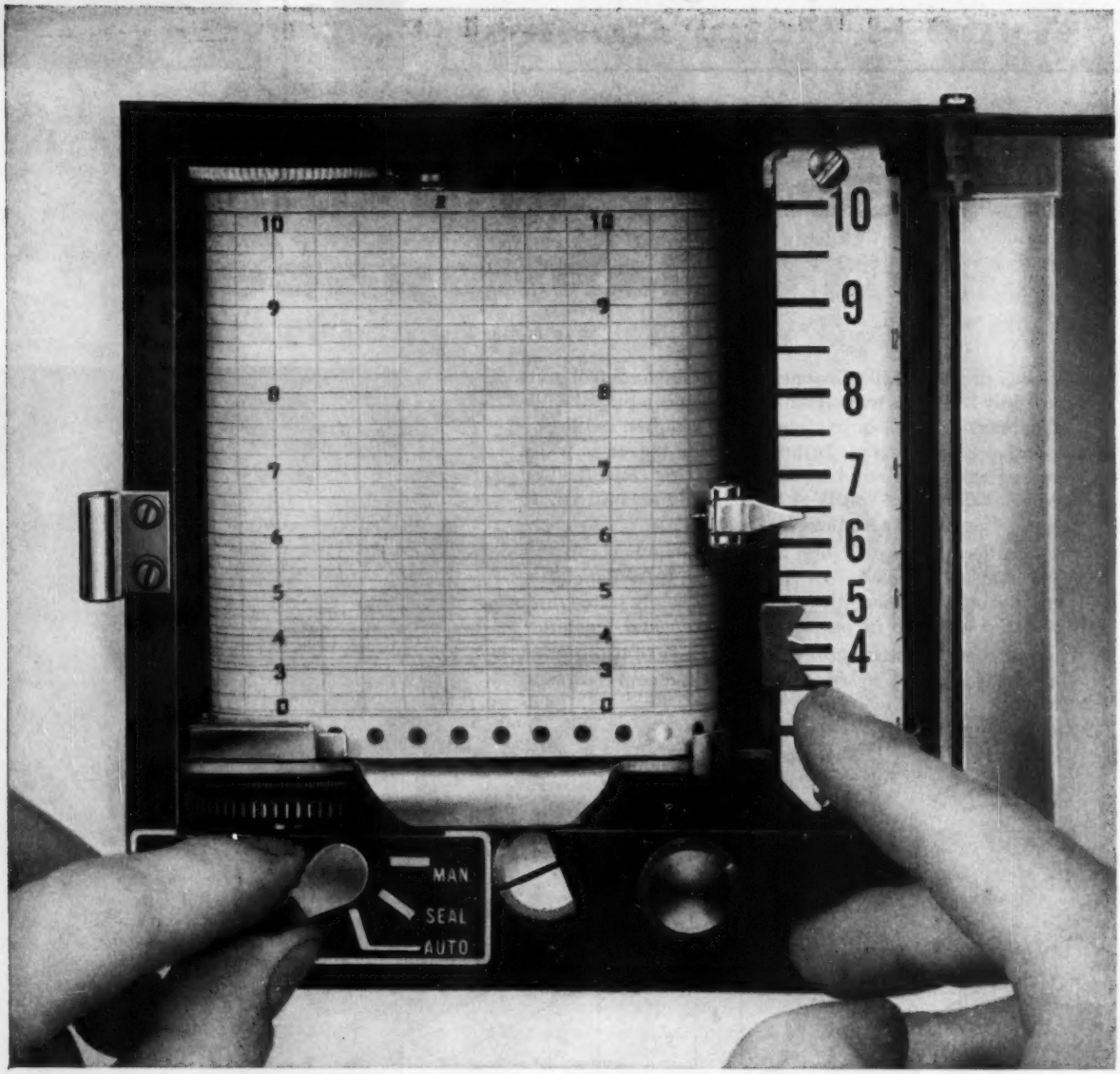


You get an extra unit in less space with Allis-Chalmers. *10* Allis-Chalmers units require only 340 inches.



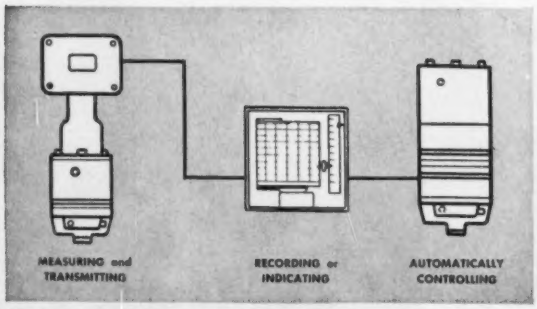
ALLIS-CHALMERS

A-5518

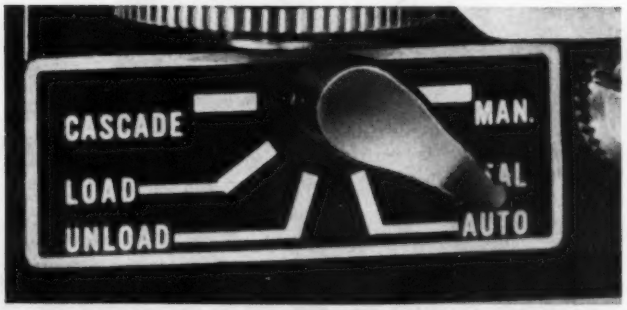


BRISTOL METAGRAPHIC RECEIVERS:

"Easiest 'bumpless



BRISTOL METAGRAPHIC INSTRUMENT SYSTEM



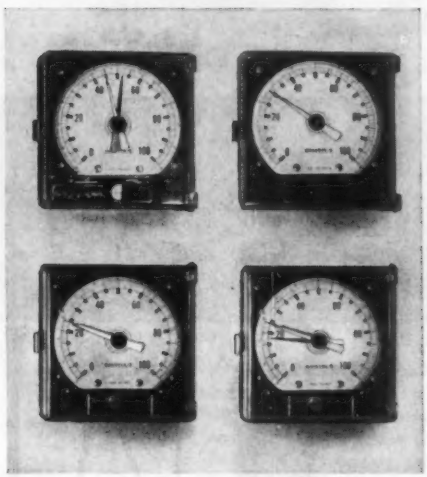
SIX-POSITION SINGLE-KNOB TRANSFER STATION (enlarged view) for cascade service. Three-position manual-automatic station is also available.

For more data on advertised products, use Readers' Service Cards, last page.

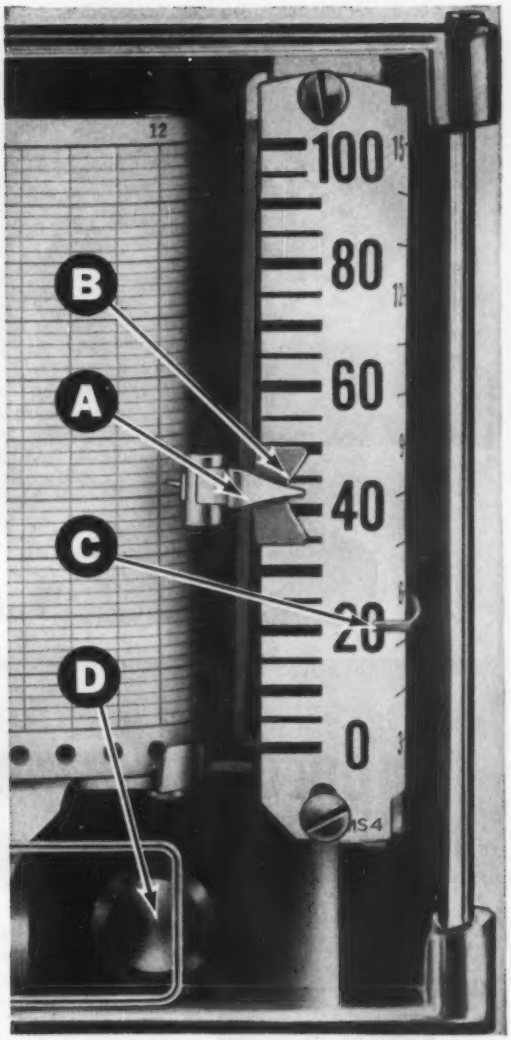
ONE OF 38 METAGRAPHIC RECEIVER MODELS you can choose from, all with 5" x 5⅛" panel, all fitting into same 4 9/16" square panel cut-out. This Metagraphic Recording Receiver has single-knob six-position transfer station, gives easy start up and initial adjustment and completely "bumpless transfer" in complex cascaded control systems. Single-knob, six-position transfer station lets you select:

1. Completely automatic-cascade operation.
2. Automatic operation of slave loop alone.
3. Manual operation.

You get "bumpless transfer" both ways between all three conditions. This convenient switching greatly facilitates start-up of cascaded systems and initial adjustment of slave controller proportional, reset, and derivative actions.



METAGRAPHIC INDICATING RECEIVERS have full 9-inch scale for easy reading; feature: Complete 10-second interchangeability with recorders, show valve position as well as set point and controlled variable. Highly visible fluorescent paint on pointers makes deviation of set point and variable instantly apparent from as far as 20 feet away.



METAGRAPHIC RECEIVER shows measured variable (A), set point (B), and valve position (C), all on same scale. That's what makes manual-automatic transfer so easy, bumpless, and error-free with this instrument . . . just seal, match pointers with knob (D), transfer—that's all there is to it.

transfer' you ever saw"

That's what instrument men say after trying the Bristol Metagraphic Pneumatic Receiver—even in complex cascade control systems.

Just seal, match pointers, transfer. There's not a single value to read. It's that easy because the Metagraphic receiver gives you one-knob control plus continuous valve position indication on the same scale with set point and measured variable.

A genuine plug-in receiver. The Metagraphic is a *true* plug-in receiver—no finger-disconnects. *It plugs and unplugs in 5 seconds with no loss of automatic control. The case acts as a blind controller while the receiver is out.*

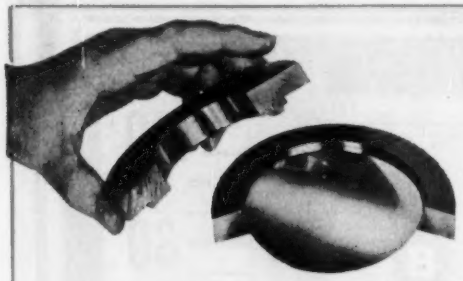
Don't pay for pre-installation errors. The Metagraphic's full plug-in versatility lets you switch from indicator to recorder in less than 10 seconds, interchange many receiver models, change recorder range simply by changing chart. Cuts down on costly reinstallations if process requirements are changed.

Write for the complete story on Bristol Metagraphic Receivers. Bristol gives you the widest selection of plug-in miniatures on the market—pneumatic, telemetering, electronic. (Full-sized instruments, too.) The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. 7.33

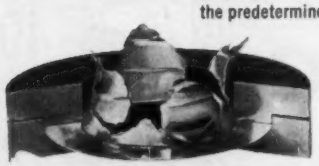
BRISTOL *TRAIL-BLAZERS IN PROCESS INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.



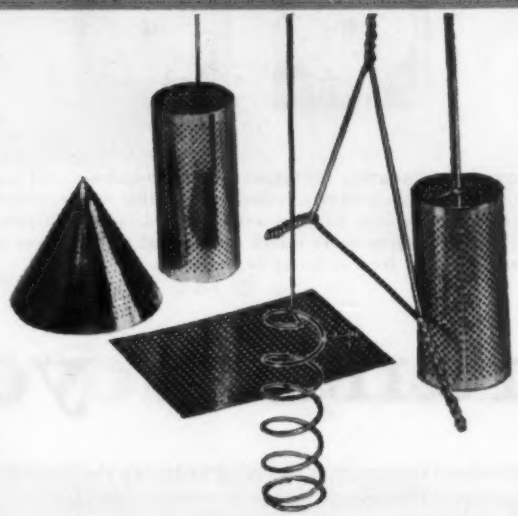
RUPTURE DISCS... discs of precious metals, resistant to most corrosive agents and unattacked under conditions that base metals could not withstand. Specific physical properties ensure bursting only at the predetermined pressure.



DEOXO® PURIFIER... provides low-cost catalytic purification of hydrogen and other gases to the extent of less than one part oxygen per million. Requires no operating expense, no maintenance, no reactivation, no auxiliary heating, no water cooler. Extremely simple installation.

important for petroleum processing...

SUPER-SENSITIVE DEOXO® INDICATOR... for measuring oxygen or hydrogen present as impurities in other gases. Accurately indicates from 0.0002% to 0.0200% (2 to 200 parts per million) oxygen, and from 0.0004% to 0.0400% hydrogen. A dual range permits measurement of up to 0.25% oxygen or 0.5% hydrogen.



LABORATORY WARE... a wide variety of forms and sizes for chemical and physical purposes, made of platinum or any desired alloy. Line includes crucibles, reshapers, triangles, dishes, electrodes, anodes and cathodes.

Write for complete catalog material and details

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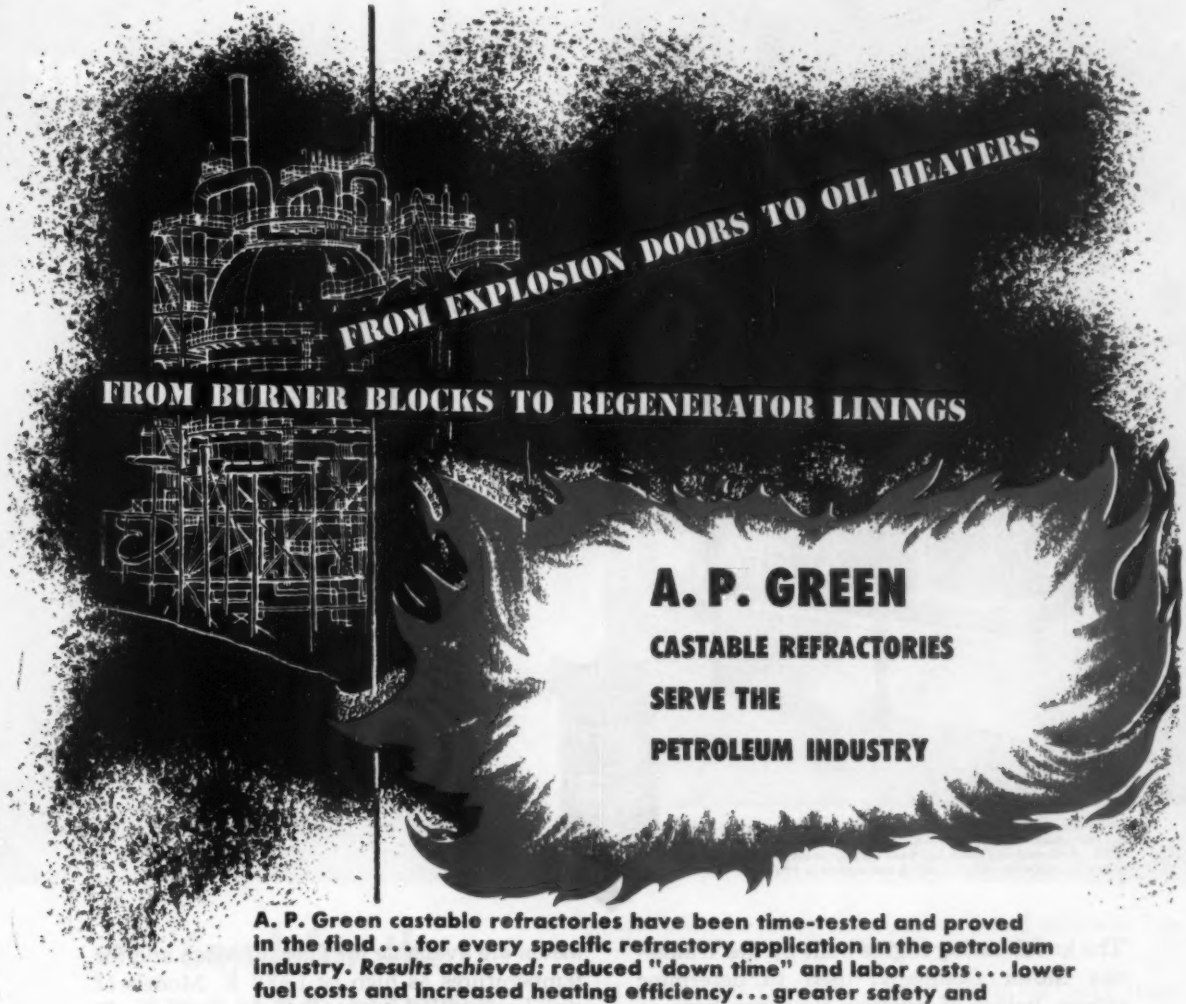

A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.

For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

KAST-SET — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

KAST-O-LITE — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

CASTABLE INSULATION NO. 20 — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

CASTABLE BLOCK MIX — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

CASTABLES FOR GUN APPLICATION . . . SK-7 — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

KS-4 — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

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For more data on advertised products, use Readers' Service Cards, last page.

Waukesha Motors' ASTM unit for determining knock characteristics by the supercharge method—ASTM D-909. Staynew filter, Model CPHB-01 (circled and inset), has been used on Waukesha-built, knock-rating engines since inception of the test method in 1942.

STAYNEW FILTERS

choice on Knock-Test Engines

The knock-rating engine built by the Waukesha Motor Company, used to determine octane values of aviation-type gasolines in industry, refineries, and research laboratories, is equipped with a Staynew filter, Model CPHB-01.

The CPHB-01 is a pressure-type filter designed for installation in horizontal pipelines handling air or other gases. Its maximum working pressure is 125 psig, an effective surplus over the 100 psig used in the Waukesha-built ASTM supercharge unit.

This filter effectively removes dust, moisture, dirt, pipe scale, and other foreign matter, and the standard filtering medium will remove dust particles as small as three or four microns (0.000156") in size. Special media are available for finer filtration and for temperatures as high as 1300° F. Models of stainless steel, bronze, or other alloys will handle corrosive gases.

Clean air is essential here because, to secure proper results, the engine must be maintained in topnotch condition. Dirty air will upset results because of the dirt's adverse effects on valves, pistons, etc.

Staynew filters have been used on Waukesha-built supercharge knock-testing engines ever since their inception in 1942. Only minimum maintenance is required.

Whatever your filtering problem, there's a Dollinger representative nearby ready to help solve it. Write today. The Dollinger Corporation, 47 Centre Park, Rochester 3, New York.

REG. PROTECTOMOTOR U.S. PAT. OFF.

STAYNEW FILTERS

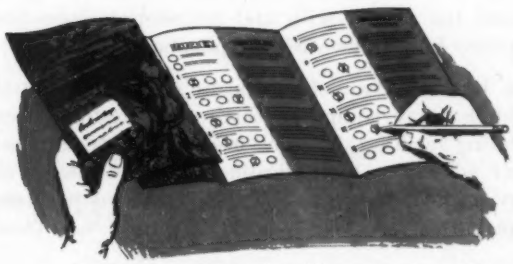
DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

For more data on advertised products, use Readers' Service Cards, last page.

Stop explosions before they blow

Send for the CROUSE-HINDS "Hazard Finder"



● The Hazard Finder will enable you to make a quick survey of the hidden probabilities of electrically-ignited explosions in your plant.

Let Crouse-Hinds equipment and technical assistance help you to prevent electrically-ignited explosions.

The more than 15,000 Condulet ® items in the Crouse-Hinds line, include the world's widest selection of explosion-proof and dust-tight electrical equipment. There are Condulet devices for every circuitry requirement, and for every hazardous area and condition. All backed by engineers and technicians thoroughly familiar with Article 500 of the National Electrical Code and its application to specific situations.

For a quick, general survey of probable dangers in your plant, send for the Hazard Finder. For technical discussion of specific areas and hazards, write for Crouse-Hinds bulletins which apply.

● Or for personal assistance, ask any of the offices listed below to send a Field Engineer.

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING ● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

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Company_____ Title_____

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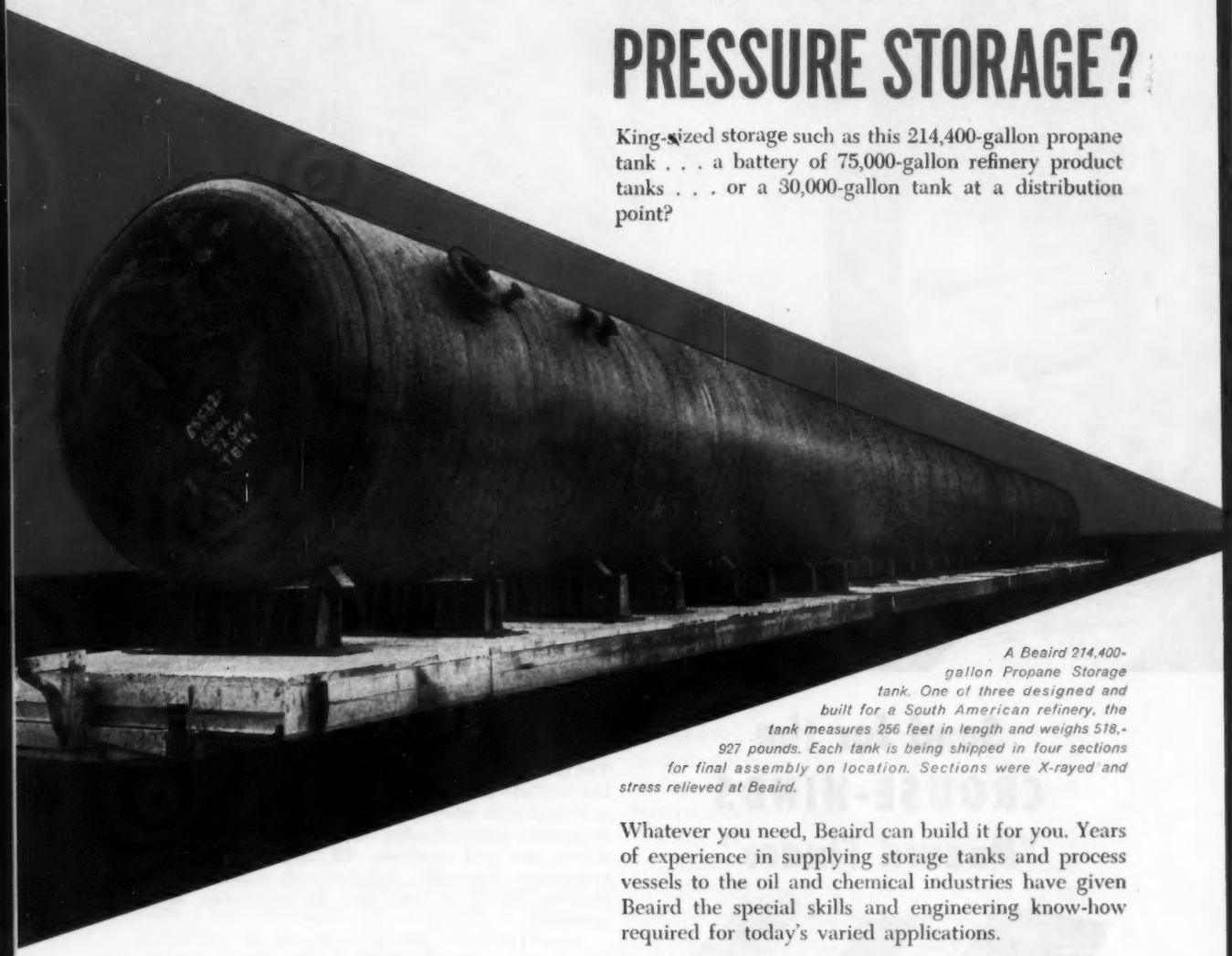
City_____ State_____

What do YOU need in PRESSURE STORAGE?

King-sized storage such as this 214,400-gallon propane tank . . . a battery of 75,000-gallon refinery product tanks . . . or a 30,000-gallon tank at a distribution point?



A Beaird 214,400-gallon Propane Storage tank. One of three designed and built for a South American refinery, the tank measures 256 feet in length and weighs 518,927 pounds. Each tank is being shipped in four sections for final assembly on location. Sections were X-rayed and stress relieved at Beaird.

Whatever you need, Beaird can build it for you. Years of experience in supplying storage tanks and process vessels to the oil and chemical industries have given Beaird the special skills and engineering know-how required for today's varied applications.

You benefit as well from Beaird's Quality Control. Modern X-ray equipment, hydrostatic testing, stress relieving facilities, full-time insurance inspectors and strict adherence to fabricating code procedures all play important roles in building Beaird pressure storage.

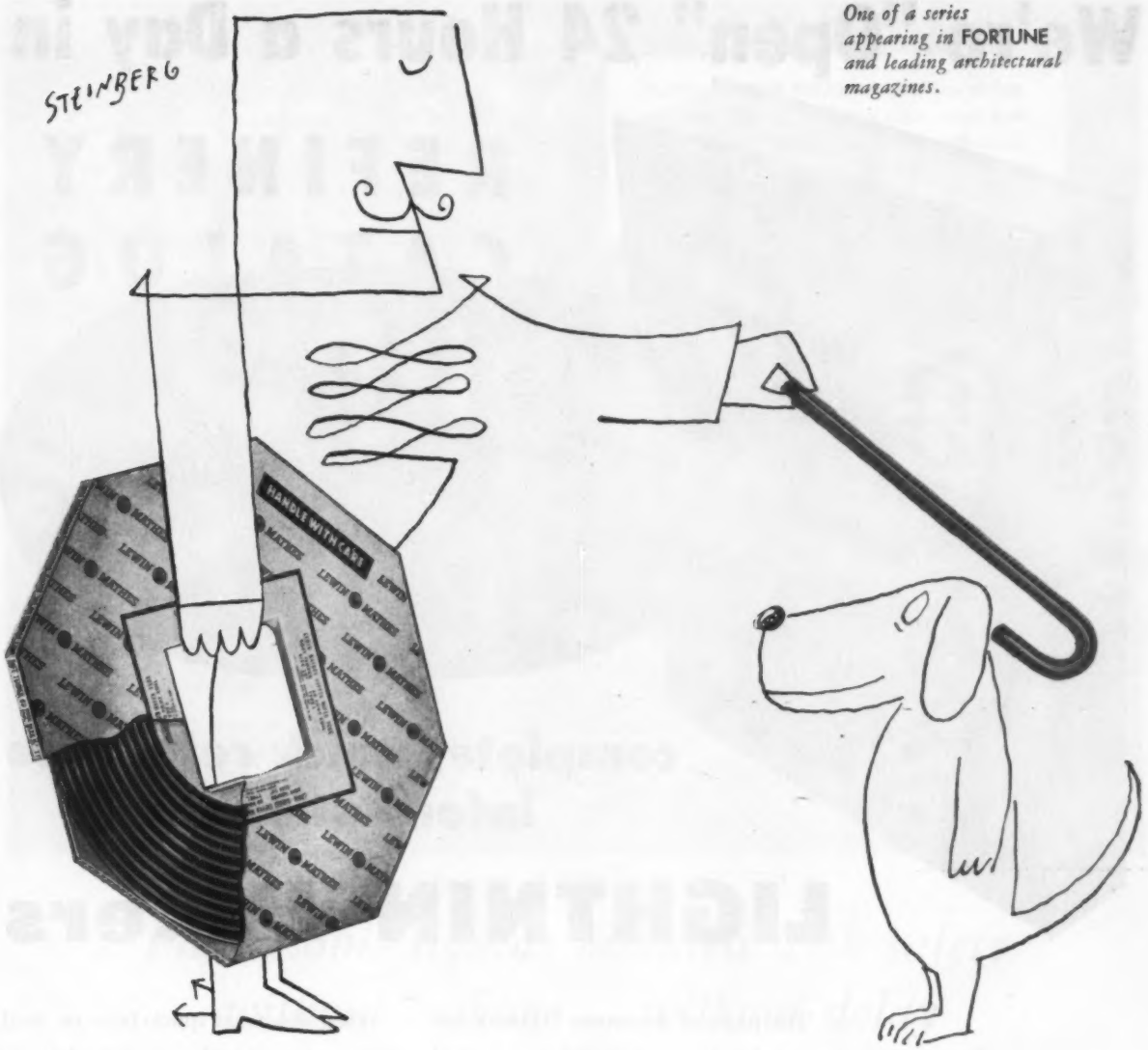
When your next project is in the idea stage, call in a Beaird sales engineer. His specialized knowledge can help you obtain maximum storage at lowest possible cost.

Over 200,000,000 Gallons Experience

BEAIRD
another AMF product
PRESSURE STORAGE VESSELS

THE J. B. BEAIRD COMPANY, INC.
A Subsidiary of American Machine & Foundry
Shreveport, La. • Stockton, Calif. • Clinton, Iowa

One of a series appearing in **FORTUNE** *and leading architectural magazines.*



dogmatic

Our plant is an obedience school for Copper.

Here, Copper becomes pure, smooth and submissive . . . meets grueling tests for strength, tolerance and uniformity . . . acquires a high degree of authority as Lewin-Mathes Seamless Tube, Pipe and Rod.

With the dogmatic fervor of the ancient coppersmith, Lewin-Mathes remains the integrated *specialist* in its field. And our pride of product extends to our nationwide service facilities . . . second to none, we believe, in efficiency.

If you use Copper tube or rod in your product . . . or are planning to build . . . ask your designer or architect about Lewin-Mathes quality. It costs no more.

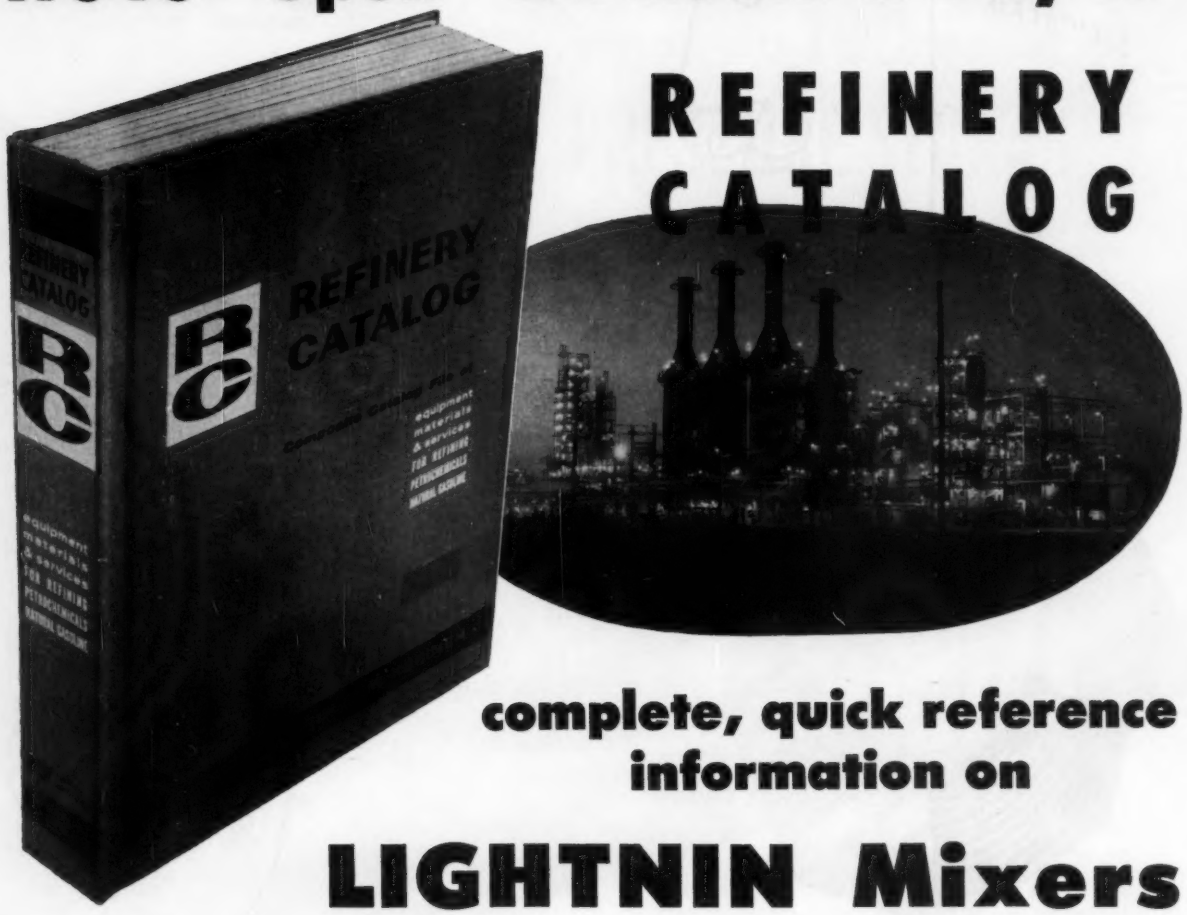
LEWIN MATHES

SAINT LOUIS, MISSOURI

COPPER AND BRASS TUBE PIPE AND ROD

DIVISION OF CERRO DE PASCO CORP.

We're "Open" 24 Hours a Day in



REFINERY CATALOG

complete, quick reference information on

LIGHTNIN Mixers

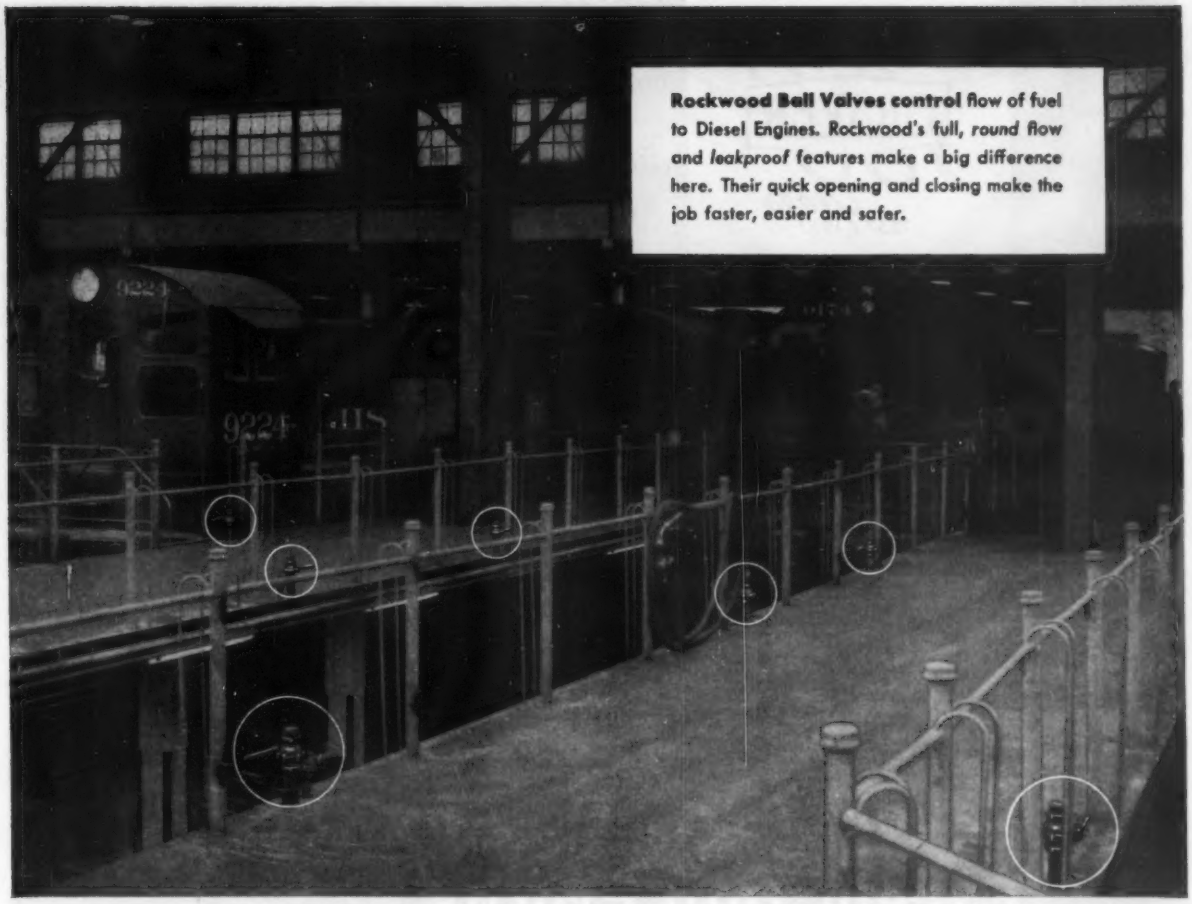
The pages of REFINERY CATALOG are never closed . . . bringing you around the clock information on products and services. Because we know you prefer such a single-source reference, we have selected this Catalog to carry our catalog data to more than 8,500 buyers and specifiers in the refining, petrochemical and natural gasoline industry throughout the world. We believe this pre-filed data will be of time-saving value and convenience to you.

When you want quick facts on fluid mixing, turn to the catalog data in Refinery Catalog. There you'll find condensed catalog information on LIGHTNIN Mixers for any type of service. The LIGHTNIN catalog unit is made up of 16 fact-filled pages on mixer construction, impeller selection, scale-up, and mixer efficiency. If you can't find all the information you need, check the list of LIGHTNIN sales representatives and call the nearest one.

MIXING EQUIPMENT Co., Inc. 135 Mt. Read Blvd., Rochester 11, N.Y.

IN CANADA: Greey Mixing Equipment Ltd., 100 Miranda Ave., Toronto 10, Ontario

For more data on advertised products, use Readers' Service Cards, last page.


Rockwood Ball Valves control flow of fuel to Diesel Engines. Rockwood's full, *round* flow and *leakproof* features make a big difference here. Their quick opening and closing make the job faster, easier and safer.

Flammable liquids handled with safety ... without leakage ... without delay

Rockwood Ball Valves are ideal for handling flammable fuel oils. They handle quickly, easily! The reasons are —

Rockwood Ball Valves with *Full Round Flow* eliminate turbulence and provide minimum friction loss.

Only a quarter turn is needed to open or close the valve.

Rockwood Ball Valves have a chrome-plated ball that holds up under tough abrasion, pitting and scratching — that means *Long Wear-Resistance.*

Rockwood exclusive corrugated spring design and the pressure of the fluid *automatically* position the ball against the seat for a completely *Leakproof Seal.*

These features pay off on handling fuel oils. Rockwood Ball Valves deliver flammable fluids at the volume you want quickly, without leakage and a minimum of maintenance. The only other thing you could ask for is more information — and the coupon below will get it for you.

Tested and listed by Underwriters' Laboratories, Inc. Distributors in principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

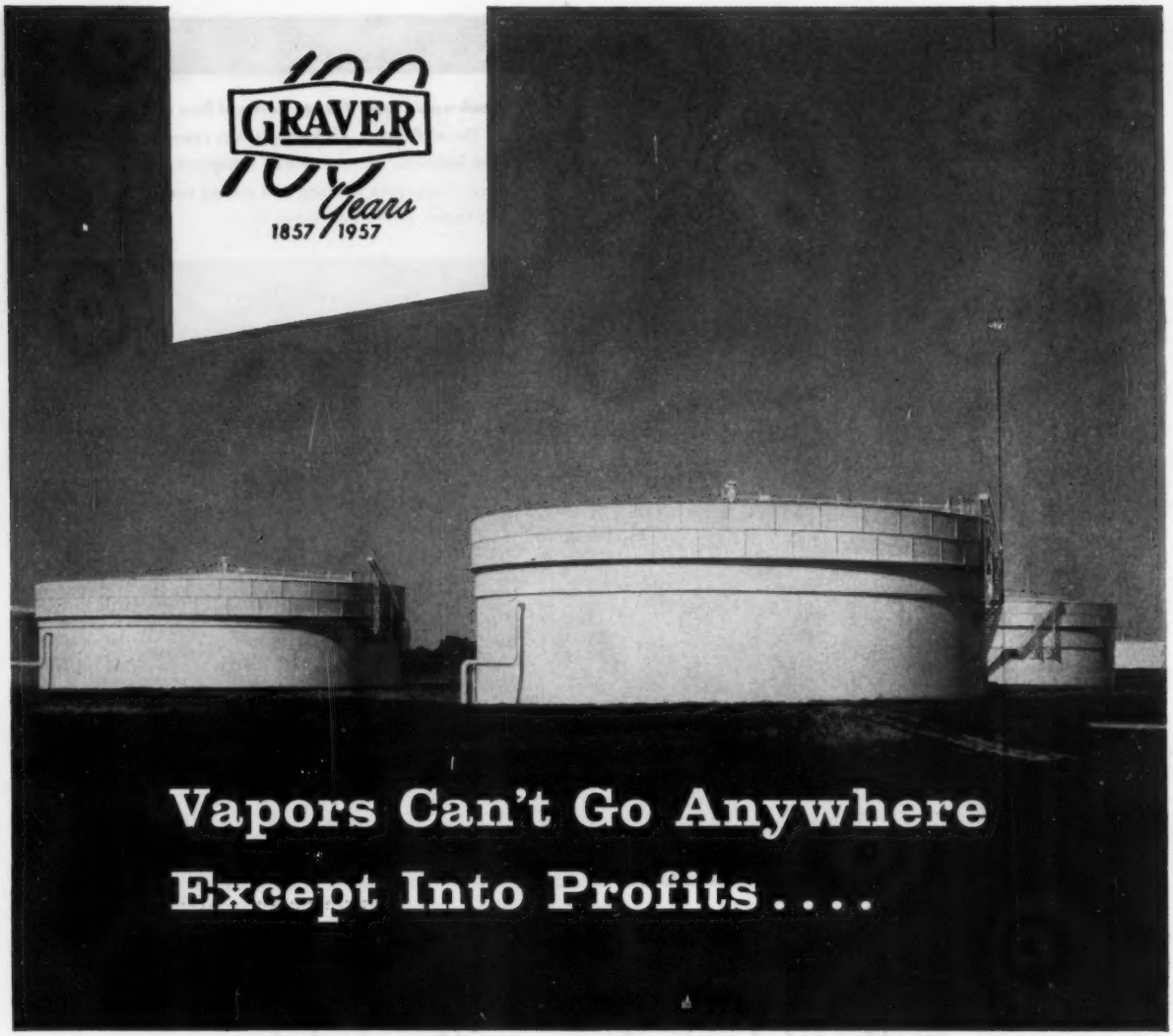
ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2227 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....
Title.....
Company.....
City.....
Zone.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.



WITH THE ROOF THAT BREATHES!

Your vapor-loss control projects find ready solution when turned over to Graver—champions of vapor conservation since the turn of the century.

For example, the efficiency of the vapor-control method provided by the patented Graver Expansion Roof® Tank has long been recognized as the most effective method for minimizing gasoline vapor losses.

This trouble-free roof virtually breathes vapors back into profits. As vapors form, the roof ascends. As they condense, the roof descends. Reabsorption of vapor is speeded by the weight of the roof. No other lifter roof matches the operating smoothness of the Graver Expansion Roof.

The volume of vapor space afforded by the 10 foot lift is ample to protect not only the contents of the Expansion Roof Tank itself, but also the product stored in adjacent manifolded cone-roof tanks as well.

If your problem is that of providing against vapor loss during the storage of product—or volatile crudes or chemicals—in single or multiple-tank installations, the Graver Expansion Roof Tank is the key to profitable operations.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

New York • Philadelphia • Edge Moor, Delaware • Pittsburgh
Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston
New Orleans • Los Angeles • Fontana, California • San Francisco

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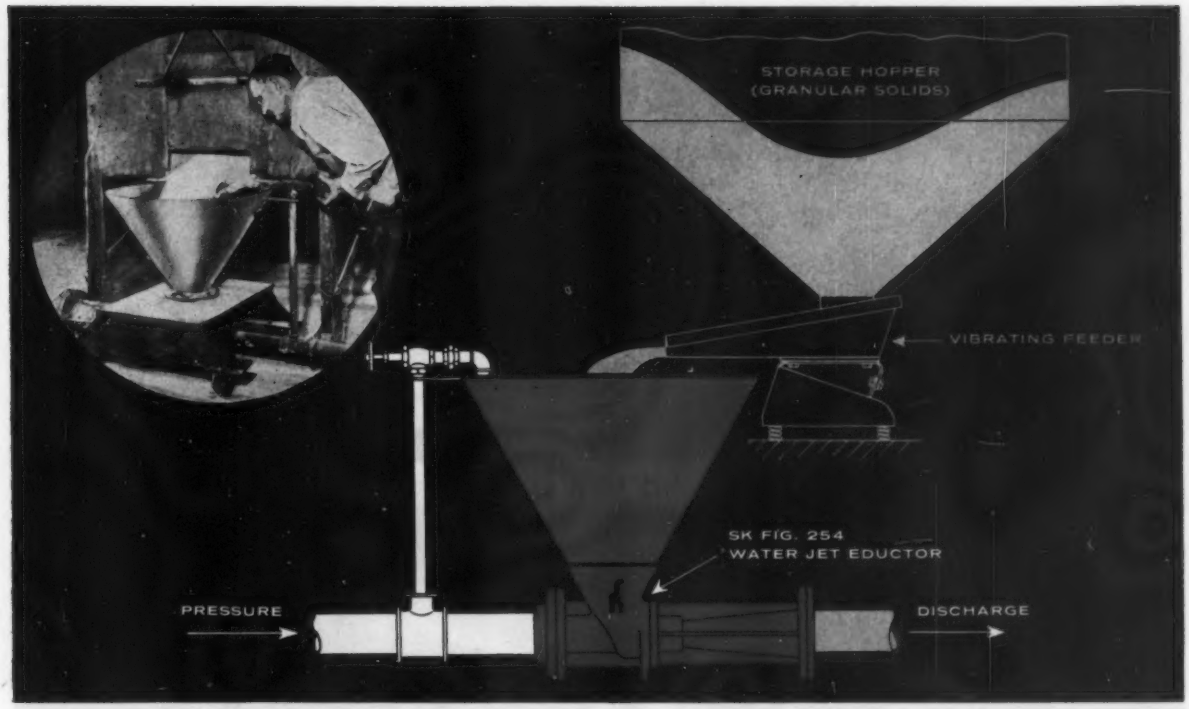
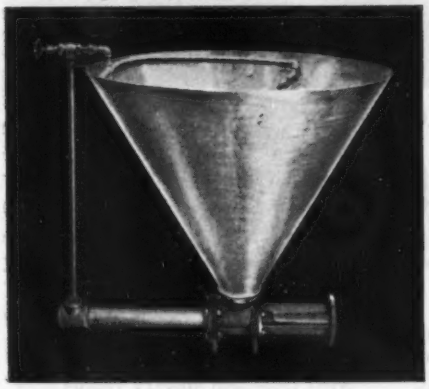


MIX SOLIDS WITH LIQUID, CONVEY SLURRIES

with this SK "Hopper Type" Water Jet Eductor

SK Fig. 254 Hopper Type Water Jet Eductor



SK's Hopper Type Eductor, shown above and at left, will mix solids with liquid and convey slurries conveniently and at low cost. See box below for types of granular solids currently being handled.

An inexpensive unit, this light-weight eductor is easy to install, simple in construction with no moving parts, requires little maintenance, and provides efficient service over long periods. In operation, pressure water, issuing through the nozzle, entrains granular solids from the hopper and discharges through discharge piping. Agitating jets keep material moving down into the eductor.

Used in the petroleum industry, in chemical processing and food processing plants, the hopper eductor has proved to be extremely satisfactory in handling the materials (bulk densities noted) listed below and others.

For full details on Hopper Type Eductors including sizes, capacities, ratios, water consumption, materials of construction, write to SK for Bulletin 2M.

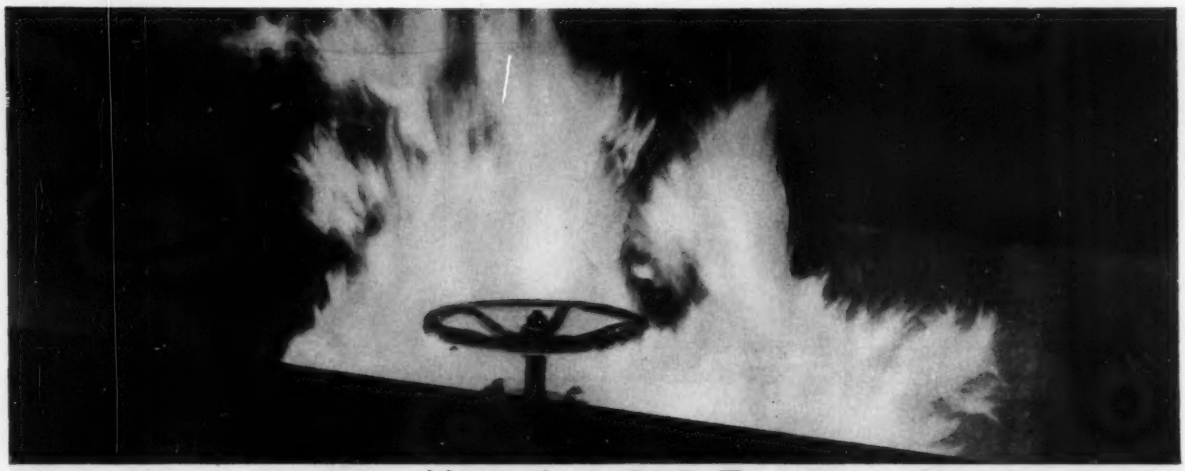
SK HOPPER EDUCTORS ARE BEING USED CURRENTLY TO HANDLE THE FOLLOWING MATERIALS *(Approx. Bulk Densities Indicated in Parentheses)*

- Borax (50-55)
- Charcoal (18-28)
- Diatomaceous Earth (10-20)
- Lime, Pebble (56)
- Lime, Powdered (32-40)
- Mash (60-65)
- Fly Ash (35-40)
- Rosin (67)
- Salt, Granulated (45-51)
- Salt, Rock (70-80)
- Sand, Damp (75-85)
- Sand, Dry (90-100)
- Sawdust, Dry (13)
- Soda Ash, Light (20-35)
- Sodium Nitrate, Dry (80)
- Sulphur, Powdered (50-60)
- Wheat (48)
- Zinc Oxide, Powder, Dry (10-35)

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.

For more data on advertised products, use Readers' Service Cards, last page.



Heated to 1350°F.

...quenched with water

Ductile iron valve withstands violent thermal shock

In a refinery fire, a valve might have to take the same treatment. Imagine what would happen if it shattered and opened the pipeline to flames?

Ductile iron valves provide safety for refineries at low cost

In the demonstration pictured above, the Walworth Company, manufacturers of valves and fittings, duplicated the conditions of a refinery blaze. To simulate stress exerted by expanding pipelines, they added heavy weights to the beams supporting the valve. And created additional stress by concentrating the oil and gas flame on one side of the valve.

When it reached a red-hot temperature of 1350°F, the valve was suddenly drenched with water.

Even after this severe test, the ductile iron valve retained its original shape and dimensions . . . showed a thermal shock safety factor *equal to more expensive steel valves!*

Provides corrosion resistance, too.

In tanker service, ductile iron valves alternately handle crude oil cargo and sea water ballast . . . experience to date predicts up to ten years service life.

Next time you specify valves – or any other equipment that demands the corrosion resistance of gray cast iron combined with the strength of carbon steel – consider ductile iron. See if it won't reduce maintenance costs for you in your own plant. It's easy to find out more about this practical metal. Simply write Inco for your copy of "Engineering Properties and Applications of Ductile Iron".

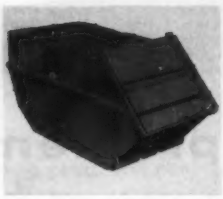
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

ductile iron...the cast iron that can be twisted and bent.

For more data on advertised products, use Readers' Service Cards, last page.

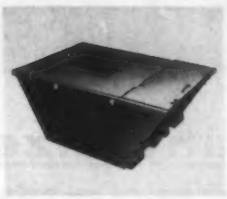
You can handle all kinds of materials with ONE TRUCK... a LOAD LUGGER hoist ...and these interchangeable LOAD LUGGER containers*...

For heavy bulk materials and machinery.



For rubbish and dry refuse.

For all types of fluids.



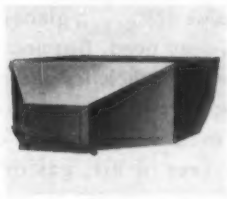
For sludge and liquids.

For granular, powdered or heated materials.

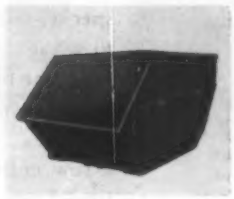
For scrap plate, sheared sections, sludge, castings, similar materials.

For carrying and discharging fluids.

For drums, lumber, pipe, similar materials.



For sand, gravel, carrying wet cement.



For light bulk materials.

*Additional types and sizes of standard and special containers are available.

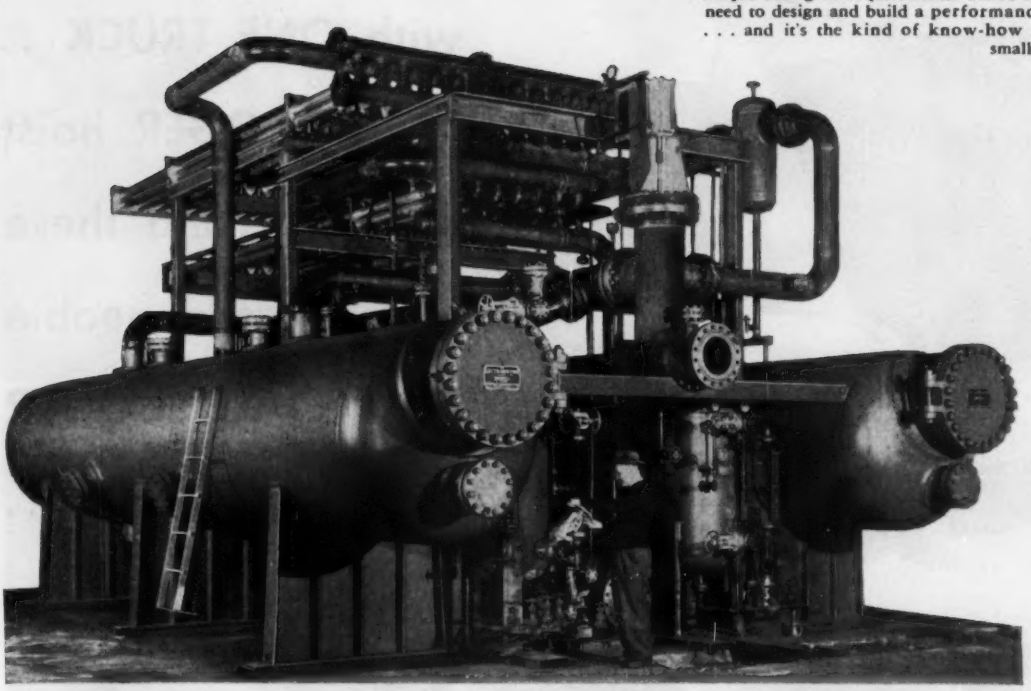
Capacities to 16 cubic yards, 24000 pounds

You get unequalled money-saving speed, flexibility and safety with The Load Lugger System of materials handling, as hundreds of users can testify. It will pay you to investigate Load Lugger now. Tell us your problem — we'll make sound recommendations for solving it.

LOAD LUGGER, INGERSOLL KALAMAZOO DIVISION
BORG-WARNER CORPORATION
18912 North Pitcher Street, Kalamazoo, Michigan, Telephone Fireside 5-3501
EXPORT SALES: BORG-WARNER INTERNATIONAL CORPORATION, CHICAGO

For more data on advertised products, use Readers' Service Cards, last page.

Lowers the dewpoint of thousands of cubic feet of gas per minute... this giant Lectrodryer grew from a simple listing of requirements. That's all our engineers need to design and build a performance-assured drier ... and it's the kind of know-how applied to the smallest Lectrodryer!



For any-size drying problem... LECTRODRYER*

The Lectrodryer shown above is a very-special-purpose drier ... a giant compared to what you may need. But you can have the same breed of efficiency and reliability in a Lectrodryer that meets your needs exactly ... even a little fellow to handle a few cubic feet of air, gas or organic liquid per hour.

Our wide experience has resulted in proven design and construction techniques that are readily adaptable to all types of requirements. No matter what capacities, temperatures, pressures or other factors are involved, we can doubtless supply a guaranteed-performance Lectrodryer which will match your requirements.

Lectrodryer's thoroughly-tested and broadly-applied principles will save you costly engineering and building time ... and the DRYing installation usually costs less than a "build-it-yourself" drier.

Stop the attack moisture is making on your product or processing operations the fast, sure way. Whether DRYing requirements are big and tough, or relatively small and uncomplicated ... ask for a Lectrodryer quotation today. Pittsburgh Lectrodryer Division, McGraw-Edison Company, 307 32nd Street, Pittsburgh 30, Pennsylvania.

Lectrodryer

*REGISTERED TRADEMARK U. S. PAT. OFF.

For more data on advertised products, use Readers' Service Cards, last page.

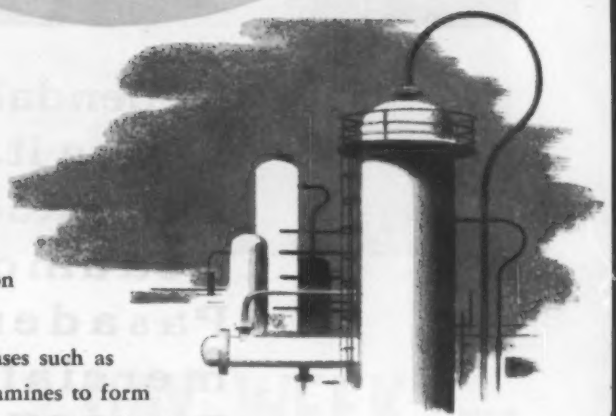
Adaptability

is TRADITIONAL at WESTERN

Adaptability

IS ESSENTIAL TO

GAS TREATING



This amine gas treating process is adaptable to the removal and recovery of hydrogen sulfide from natural and refinery gases, for desulfurization and dehydration of natural gas, for purification of liquid hydrocarbons, and for separation of carbon dioxide from hydrogen and synthesis gases.

The process was developed upon the principle that acidic gases such as hydrogen sulfide and carbon dioxide react with certain amines to form compounds which may be broken down by heat. Heat exchangers, therefore, play an important role in the conservation of heat in the process.

The adaptability of Western's engineering, design and fabricating facilities to the varying requirements of different processes typifies the versatility and flexibility of Western's manufacture of efficient, economical heat transfer equipment.

Western heat exchangers are performing efficiently in many gas treating applications throughout the petroleum industry.

A Western representative can aid you today.

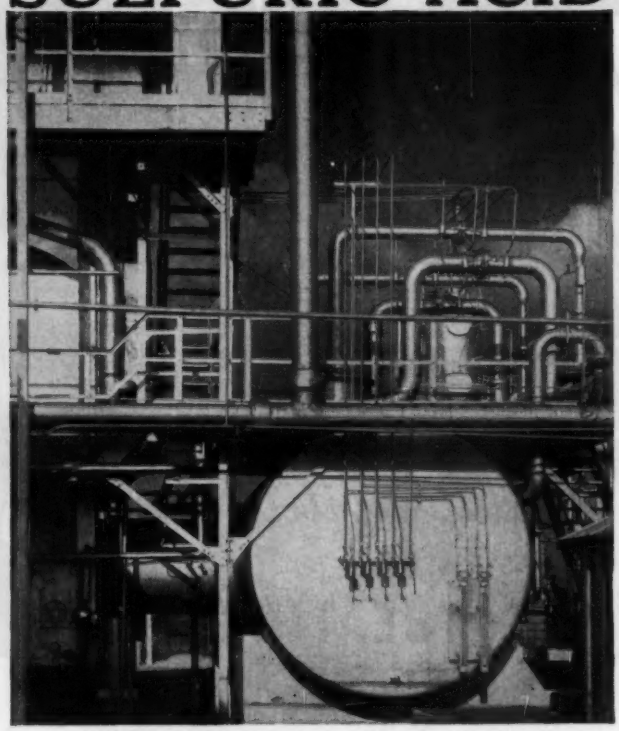
WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P.O. Box 1888 – Tulsa, Oklahoma

SULFURIC ACID



Dependability? Six shipping points assure it. Where? Baltimore, Md., Little Rock, Ark., Bossier City, La., Beaumont, Port Arthur, and Pasadena, Tex. Seven commercial grades: 60° Be., 66° Be., 98%, 99%, 100% H_2SO_4, 20% Oleum (104.5% H_2SO_4), and 25% Oleum (105.63% H_2SO_4). All plants ship in tank cars and tank trucks; barge shipments from Baltimore. More information? Waste acid disposal problems? Call today.

Ammonia
Ammonium Nitrate
Bicarbonate of Soda
Carbon Dioxide
Caustic Potash
Caustic Soda
Chlorine
Ethylene Diamine
Formaldehyde
Hexamine
Hydrazine and Derivatives
Hypochlorite Products
Methanol
Muriatic Acid
Nitric Acid
Polyamines
Soda Ash
Sodium Chlorite Products
Sodium Methylate
Sodium Nitrate
Sulfate of Alumina
Sulfur (Processed)
Sulfuric Acid

MATHIESON

MATHIESON CHEMICALS

Olin Mathieson Chemical Corporation, Industrial Chemicals Division, Baltimore 3, Md.

For more data on advertised products, use Readers' Service Cards, last page.

This Sunday Drive
REQUIRES A 7-DAY WEEK

Today's refineries are working on an around-the-clock basis and one of the reasons is the ever increasing demand for automotive gasoline. With the number of vehicles on the road still increasing, many experts foresee a 4 percent increase in the sale of gasoline and diesel fuel this year.

Polyrad—a filming amine inhibitor and detergent—can help refineries maintain peak production. As a detergent, Polyrad keeps metal surfaces clean to maintain throughput and increase heat transfer. As an inhibitor, Polyrad reduces corrosive damage to a minimum; cuts down time for maintenance.

If you are among the few who are not familiar with Polyrad, a Hercules representative will be glad to discuss how this product can meet your specific requirements. Polyrad is always quickly available from conveniently located stocks throughout the country and overseas.

Pine Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY
INCORPORATED

900 Market St., Wilmington 99, Del.

REFINERS RELY ON

POLYRAD®

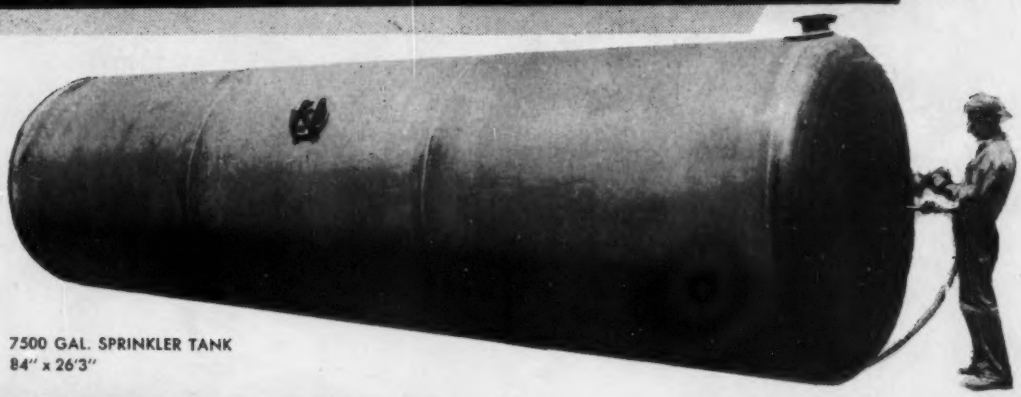
FILMING AMINE INHIBITOR

NA57-3

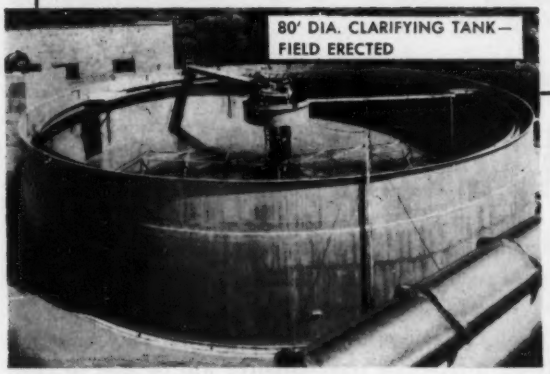
For more data on advertised products, use Readers' Service Cards, last page.

STAINLESS STEEL CONCENTRATOR WITH 7'6" OD VAPOR HEADS

76 years of KOVEN fabricating experience built into every job



7500 GAL. SPRINKLER TANK
84" x 26'3"



80' DIA. CLARIFYING TANK—FIELD ERECTED

DRYING DRUM OF STAINLESS STEEL

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; large diameter fabricated piping and plate exhaust ducts; shop and field erected storage tanks; high vacuum testing.

SPECIALISTS IN INTRICATE FABRICATION USING:

STAINLESS STEEL • ALUMINUM
MONEL • NICKEL • INCONEL
ALL CLAD MATERIALS
NICKEL PLATED STEEL
FABRICATION TO ALL A.S.M.E. CODES

See Sweet's Catalog File and Chemical Engineering File

Koven

Telephone: FOxcroft 6-0400

Call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550. Members of Steel Plate Fabricators Association.

KOVEN FABRICATORS, INC. • 91 E. DICKERSON ST., DOVER, NEW JERSEY

PLANTS: JERSEY CITY, N. J., DOVER, N. J., TRENTON, N. J.

Complete control
of temperatures with
PABCO
PRECISION-MOLDED
CALTEMP
a Calcium Silicate
Insulation

Name your temperature. A performance-proved Pabco pipe or block insulation will maintain it at economical levels up to 1900° F. With Pabco Caltemp, 85% Magnesia, or Prasco Insulations, heat losses are reduced to an absolute minimum . . . finest performance assured. For data on technical advantages, case histories, or engineering consultation . . . write . . . or contact one of Pabco's insulation engineers.

PABCO **INDUSTRIAL INSULATIONS DIVISION**

Fibreboard Paper Products Corporation • San Francisco 19 • Chicago 54 • Houston 4 • New York 16 • Los Angeles

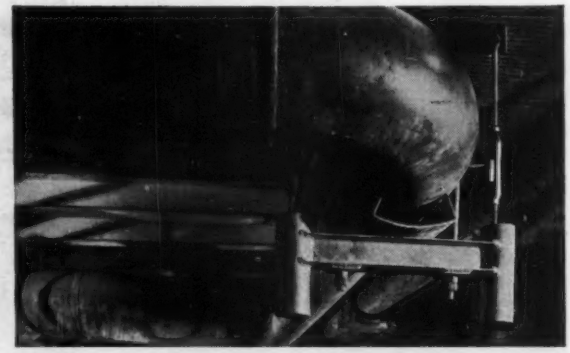
For more data on advertised products, use Readers' Service Cards, last page.

BLAW-KNOX has what it takes—to provide these products and services

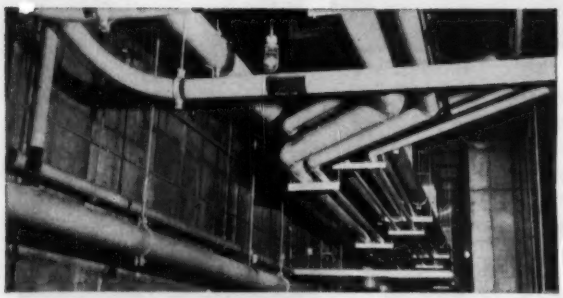
A Blaw-Knox automatic sprinkler system could have prevented this disastrous fire. Each year a serious fire strikes one out of seven manufacturing firms in this country. And out of every 100 firms who lose their records in a fire, 43 never reopen for business. So why take any chances.

Blaw-Knox engineers, fabricates and installs automatic sprinkler systems that are always alert to detect, confine and quench a fire at its origin. Qualified engineers custom-design systems that meet individual requirements—and fulfill all insurance standards and municipal codes. A Blaw-Knox automatic sprinkler system pays for itself in a few years through savings in reduced insurance premiums.

Let a Blaw-Knox fire-protection engineer study your needs, submit a layout and estimate, and tell you how you can pay for the system on our lease or deferred payment plan. For more complete information, write for Bulletin No. 2426—"Fire Can Destroy Your Business."



Blaw-Knox trapeze functional spring hangers, with the patented internal swivel action, support power piping in new generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. For further information, send for Catalog No. 54.



High temperature, high pressure oil tunnel piping in large steel mill is typical of many piping systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we will provide the service you need. For additional information, write for Bulletin No. 2443—"Piping for Industry."

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures . . . complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators . . . complete line of automatic sprinkler systems for standard and special hazards

Stone & Webster Engineering Corporation can help YOU!

Stone & Webster Engineering Corporation has helped large and small companies in practically every country in the free world with specialized engineering services ranging from the development of a new welding technique to the design and construction of complete oil refineries.

The Corporation is experienced and equipped to help you with Design, Construction, Consulting Engineering, Reports, Appraisals and Examinations.

And as a completely integrated organization Stone & Webster Engineering Corporation can handle a single engineering phase or take full responsibility for the completion of major projects.

For further details write for our booklet on "How Stone & Webster Engineering Corporation Can Help You".

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

FROM OIL: curb-to-curb carpet for America's roads. Gleaming black asphalt ribbons our highways from coast to coast. Its low first cost, economical maintenance, velvety smooth surface, and long life are the main reasons that 75% of today's asphalt production goes to make better roads. Why should *you* be interested? First, because asphalt is an important petroleum product, and second, because as a taxpayer you get more miles per taxpayer dollar—an extra mile in every ten! So every chance you get, speak up for asphalt—and better roads at lower cost. **SHELL OIL COMPANY**

TI announces DATA GAGE*

Remote Liquid Level Measurement System

The DATA-GAGE is the direct product of Texas Instruments working closely with the engineers of a leading oil company. The result is the first transistorized automatic tank gauge that gives you *triple-check* reliability, dependable Power Float accuracy to 1/16 inch, low maintenance, operational simplicity, and 100-tank capacity in ONE LOW COST SYSTEM!

Eliminates Costly Errors—DATA-GAGE does not depend on alertness of operator to catch errors. System *automatically triple-checks* itself for accuracy before any data is displayed: 1. Operational check of Power Float; 2. Identification of tank connection; 3. Telemetering check for correctness and completeness of data.

Dependable Accuracy Under All Conditions—1/16 inch accuracy at depths of zero to 64 feet. No need to recalibrate over a wide range of liquids, temperatures and specific gravities. DATA-GAGE is the *only* system to give reliable readings during blending turbulence.

Low Initial and Long-range Cost—DATA-GAGE is a complete measurement system requiring no expensive extras. No special transmission system or conduits are required at installation—often existing ground level gauge connections and pipes can be utilized. Transistors are used instead of short-lived vacuum tubes. Easy access and quick-disconnect parts in all units make this the easiest to service of all systems.

Operational Simplicity—operator simply dials tank number and awaits data to be displayed seconds later on the exclusive DataFLASH reading panel. He need not make comparative readings to determine errors—DATA-GAGE automatically checks itself.

Power Float Reliability—the mechanical surface finder is a moving rather than static float, registers the instant surface tension is broken. No possibility of tilting, locking or sticking and giving an erroneous reading.

Proved Telemetering—true digital system employs digital code in binary decimal form. Means of transmission is a completely redundant (code group and its complement are transmitted), three-state code, the reliability of which has been thoroughly proved in transatlantic telegraphy.

Utmost Safety Precautions—field units are plug-in type which may be removed to safe area for servicing. No electric wires enter the tank. Explosion-proof housings are available on all field units.

For complete detailed information on the modern DATA-GAGE system, write for Bulletin No. M-601.

TEXAS INSTRUMENTS INCORPORATED

INDUSTRIAL INSTRUMENTATION DIVISION

3609 BUFFALO SPEEDWAY • HOUSTON, TEXAS • CABLE: HOULAB

*TRADEMARK REGISTRATION APPLIED FOR.

Traffic World, Sept. 21

'Major Potential' for Tank-Car Builders Is Maximum-Load Cars, Says ACF Official

J. P. Krumech Tells National Petroleum Ass ... That Such Cars For High-Pressure Commodities Are Possibl ... Fleets.

Oil Daily, Sept. 13

Rising Trend to Large Capacity Tank Cars Cited at NPA Parley

ATLANTIC CITY, Sept. 12—J. P. Krumech, vice president of Shippers' Car Line division, ACF Industries, Inc., today told the tran...

The ACF official acknowledged that there are some ... for oil companies ...

Wall Street Journal, Sept. 13

New High-Pressure Tank Cars Expected to Be In Production Shortly

By a Wall Street Journal Staff Reporter

NEW YORK—Larger, maximum-load tank cars for high-pressure commodities—liquefied gases—will soon be out of the development stage and in large-scale production, according to J. P. Krumech, vice president in charge of sales of Shippers' Car Line division of ACF Industries, ...

Four points that made news highlighted the talk given by ACF Industries' J. P. Krumech at the National Petroleum Association's annual meeting in Atlantic City on Sept. 12.

1. Money-saving maximum-load railroad tank cars for many commodities are available now;
2. For *petroleum products*, 19,000-gallon cars with 90 per cent greater lading capacity than 10,000-gallon cars cost only 27 per cent more;
3. For *high-pressure commodities* (liquefied gases), 20,000-gallon cars are practical and are now in the development stage;
4. Uninsulated tank cars (only recently approved by the ICC for high-pressure ladings) cost less and carry more.

A qualified leader of today's trends, ACF has built maximum-load tank cars for heavy low-pressure commodities since 1929 ...maximum-load cars for petroleum products since 1953 ...uninsulated cars for high-pressure commodities since July of this year. ACF has delivered more King Size fuel-oil tank cars than any other manufacturer, and continues to advance its research on maximum-load tank cars for high-pressure commodities.

Additional information is available at:

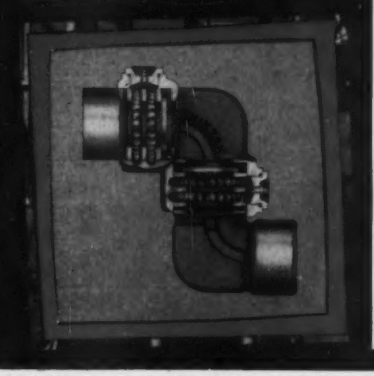
SHIPPERS' CAR LINE
DIVISION OF ACF INDUSTRIES INCORPORATED
30 CHURCH STREET, NEW YORK 7, N. Y.
WOrth 4-3010
Sales Offices: Chicago, Ill. • Houston, Tex. • San Francisco, Cal. • Cleveland, Ohio • Tulsa, Okla.

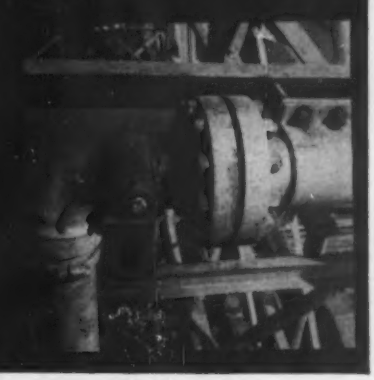
19,000-GALLON ACF KING SIZE TANK CAR for petroleum products (right) has 90 per cent greater capacity than standard car, costs 27 per cent more.

CHIKSAN HELPS UNION OIL CUT OUT THE COKE

Swiveling Chiksan Decoking Arms combine flexibility and stamina to handle 1700 psi hydraulic water force used to remove petroleum coke from coke drums

During refining of crude stock at Union Oil's Oleum refinery, petroleum coke is produced as a valuable by-product. When coke drums become full, they are "decoked" with a high pressure water jet which first drills out a pilot hole, then cuts the coke loose, moving it out of the tower in slurry form. Safety dictates all metal flexible lines. The solution—Chiksan Swivel-Jointed All Steel Decoking Arms. These rugged units provide free turning rotation with all movement carried out in a predetermined arc. Service life of the Chiksan Decoking Arms is measured in years and maintenance involves an occasional packing replacement. If your equipment or plant lines require flexibility, let Chiksan swivel joints provide the answer with less maintenance, limited replacements, and the safety that only steel can provide. Write today for literature and price lists.





LOOK INSIDE A SWIVEL JOINT. Detailed attention to detail. Precision machining and specific packing seals for specific services. These are the quality-plus features built into every Chiksan Swivel Joint.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

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CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada Ltd.

#57-29

An Inside Peek at Steam Trap Capacity Ratings

or... how to be sure steam heated equipment is going to work the way it's engineered

WHEN YOU GET all through engineering a steam heated process equipment installation, its performance will depend on whether your steam traps will do what the catalog said.

Now, in theory, if you know the size of a steam trap orifice, you can figure how much water can be pushed through it in a given time by a given steam pressure. But, in practice, this doesn't work out. The picture is scrambled by things like the choking effect of flash steam and restriction of flow through the trap and piping.

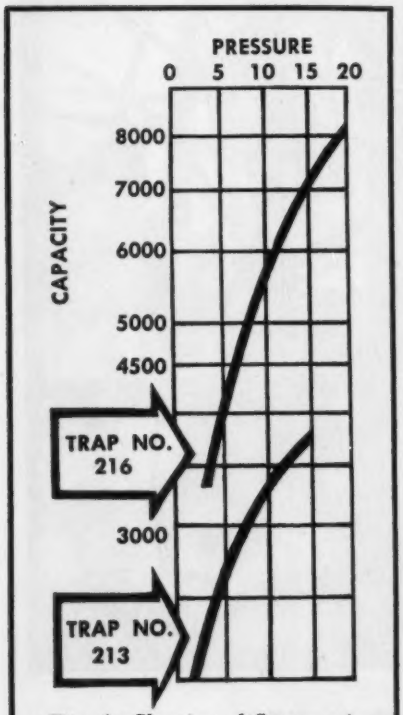


Fig. 1—Showing difference in volume of condensate discharged by a No. 216 trap with 2" pipe connections and a No. 213 trap with ¾" pipe connections—each trap having ½" discharge orifice.

For example, Fig. 1 shows that a ½" orifice in a 125 psi No. 216 Armstrong steam trap with 2" pipe connections will discharge 7200 lb/hr condensate at 15 psi inlet pressure. Yet, a ½" orifice in a 15 psi No. 213 trap with ¾" pipe connections, discharges but 3900 lb/hr at 15 psi inlet pressure. The difference: pipe friction.

Thus, we see a need for investigating the basis for steam trap capacity ratings. Unfortunately, they are not all arrived at in the same way. If they are based on cold water tests, producing no flash steam, they are much too high. Orifice tests are also too high because they ignore pipe friction. Calculations involving flow-through-orifice formulae have never been known to be conservative insofar as traps are concerned.

Armstrong Ratings

Armstrong trap capacity ratings are based on actual operating conditions, determined by hundreds of tests. In these tests condensate at the steam temperature corresponding to test pressure was used. Restriction of flow caused by the choking effect of flash steam, as well as the back pressure created by flash steam and condensate, automatically were taken into account. Actual installation hookups were used, so that pipe friction in both inlet and discharge lines also was reflected in the results.

All this effort assures you the nice, comfortable feeling that comes from knowing a trap will deliver on the job the full capacity claimed in the catalog.

* * *

There is one more ingredient that needs to be tossed into the trap-sizing pot. This morsel is the safety factor—the required excess of trap capacity over calculated condensate load. It will be the subject of the next advertisement in this series. But, in the meantime, if you'd like to get the lowdown, ask for a copy of the 44-page Armstrong Steam Trap Book. It is a complete guide to good trapping practice. It covers not only safety factors, but calculation of condensate loads and trap selection installation, troubleshooting and maintenance. Just call your local Armstrong Factory Representative, or write: **Armstrong Machine Works, 8528 Maple St., Three Rivers, Michigan.**

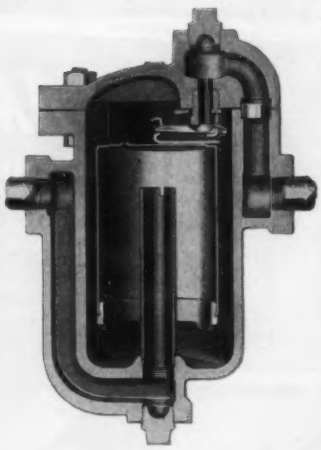
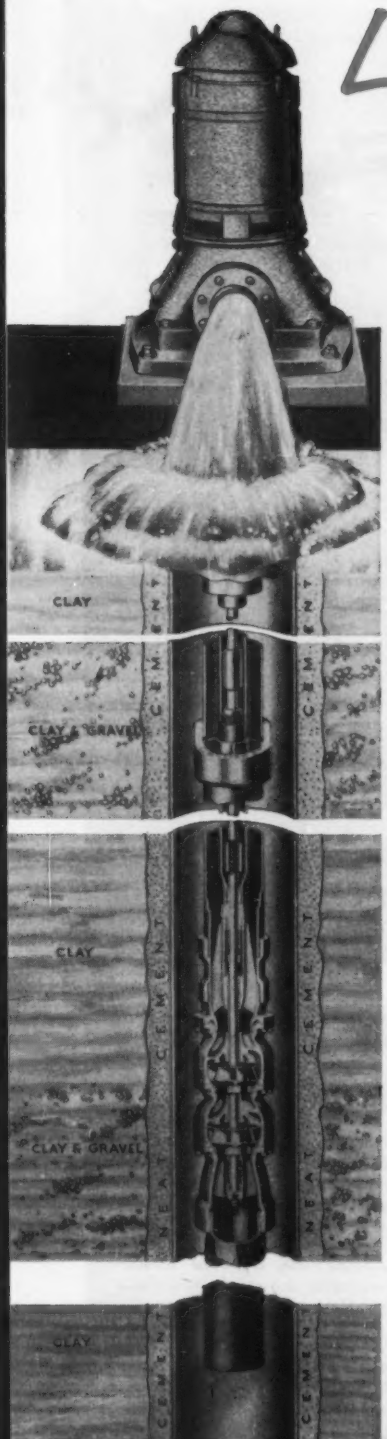


Fig. 2—Armstrong inverted bucket steam trap—hardened chrome steel valve and seat—stainless steel lever and bucket—simple, dependable, long-lived.

ARMSTRONG STEAM TRAPS

Layne knows more about water bearing formations!



On whose say-so? Not on ours—but on the experience of scores of American and foreign firms and municipalities whose very existence and success depend on an adequate supply of water.

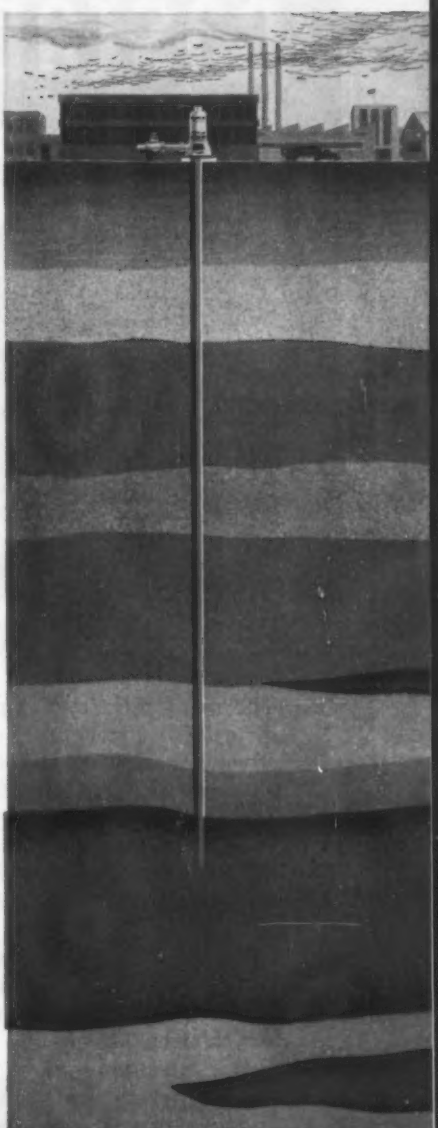
Knowing where the water is — and then tapping the subterranean source is but a part of the vast knowledge the Layne organizations have accumulated in three quarters of a century.

Once the source is determined and the water supply developed, a dependable means for delivering the water must be provided, and that's where the famous Layne pump comes in. For each Layne pump is specifically engineered for the particular job. There is no "stock" Layne pump. Your pump is created for your job —making use of the knowledge of strata, water requirements and usage.

ENGINEERED, DEPENDABLE PERFORMANCE IS WHAT YOU GET WHEN LAYNE DOES THE JOB— COMPLETE FROM WATER LOCATION TO YEAR AFTER YEAR OF TROUBLE-FREE PUMPING.

YOUR NEXT WELL AND PUMP INSTALLATION MAY BE MONTHS OFF. GET TO KNOW THE LAYNE FOLKS IN YOUR AREA. SAVE TIME AND MONEY THROUGH THEIR INTIMATE KNOWLEDGE OF WATER.

Send now for our general services bulletin No. 100.



1882 — 1957
Layne
75 YEARS OF PROGRESS

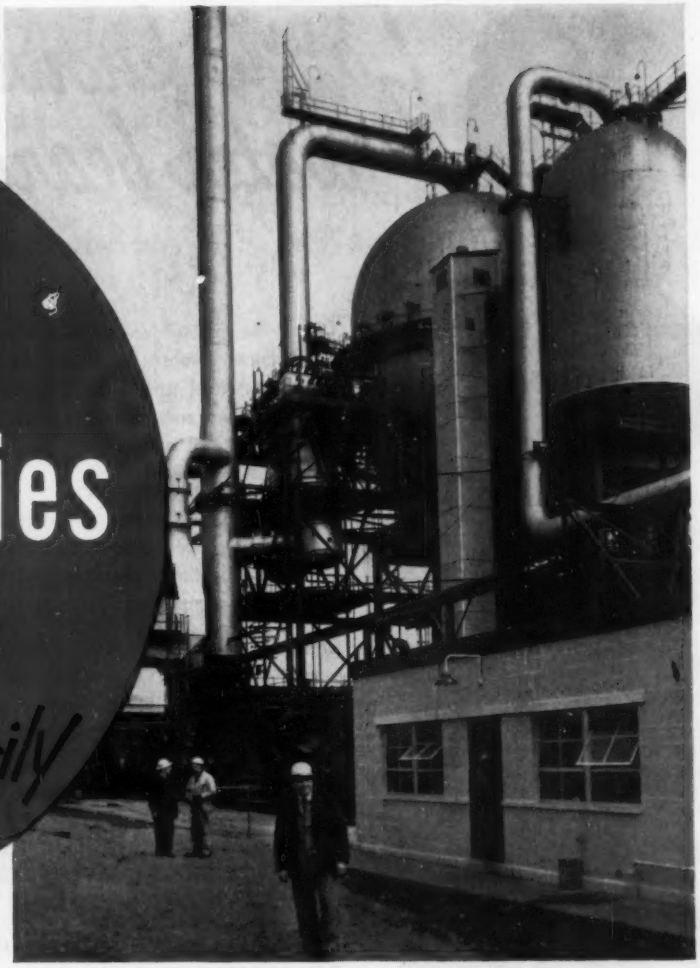
WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

LAYNE & BOWLER, INC. MEMPHIS

General Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Harbison-Walker castable refractories do many refinery jobs *most satisfactorily*



The many refractory requirements for the diversified refinery units are fulfilled most advantageously by Harbison-Walker Castables especially adapted for each particular purpose.

The excellent service resulting from the use of the various classes of Harbison-Walker Castable Refractories is due to their desirable properties, such as volume stability and strength over a wide temperature range, low permeabilities and thermal conductivities, and their high resistance to abrasion and chemical attack.

The brief descriptions of the brands of Harbison-Walker Refractory Castables principally used for refinery service, at the right, serve to illustrate their outstanding properties.

HARBISON-WALKER CASTABLES

H-W EXTRA STRENGTH CASTABLE—Is exceptionally strong and withstands severe abrasion and erosion over the range of temperatures up to its service limit of 2400°F.

H-W 56 LIGHTWEIGHT CASTABLE—Combines lightweight with high insulating value and strength to the utmost degree. Produced also with a very low ferric oxide content of less than 0.5%, it provides maximum resistance to reaction with various gases.

H-W HIGH ALUMINA CASTABLE—Made with crystalline alumina base, it is most refractory among castables and due to its extreme purity is especially suited for use in highly reducing atmospheres.

HARCAST—Exceedingly strong and resistant to reducing conditions at operating temperatures and meets rigid specifications used in the petroleum industry. Its composition and low permeability greatly retards corrosion by gases under high pressures.

These castables may be applied by casting, troweling or gun placement.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES *General Offices:* Pittsburgh 22, Pennsylvania

WORLD'S MOST COMPLETE REFRACTORIES SERVICE

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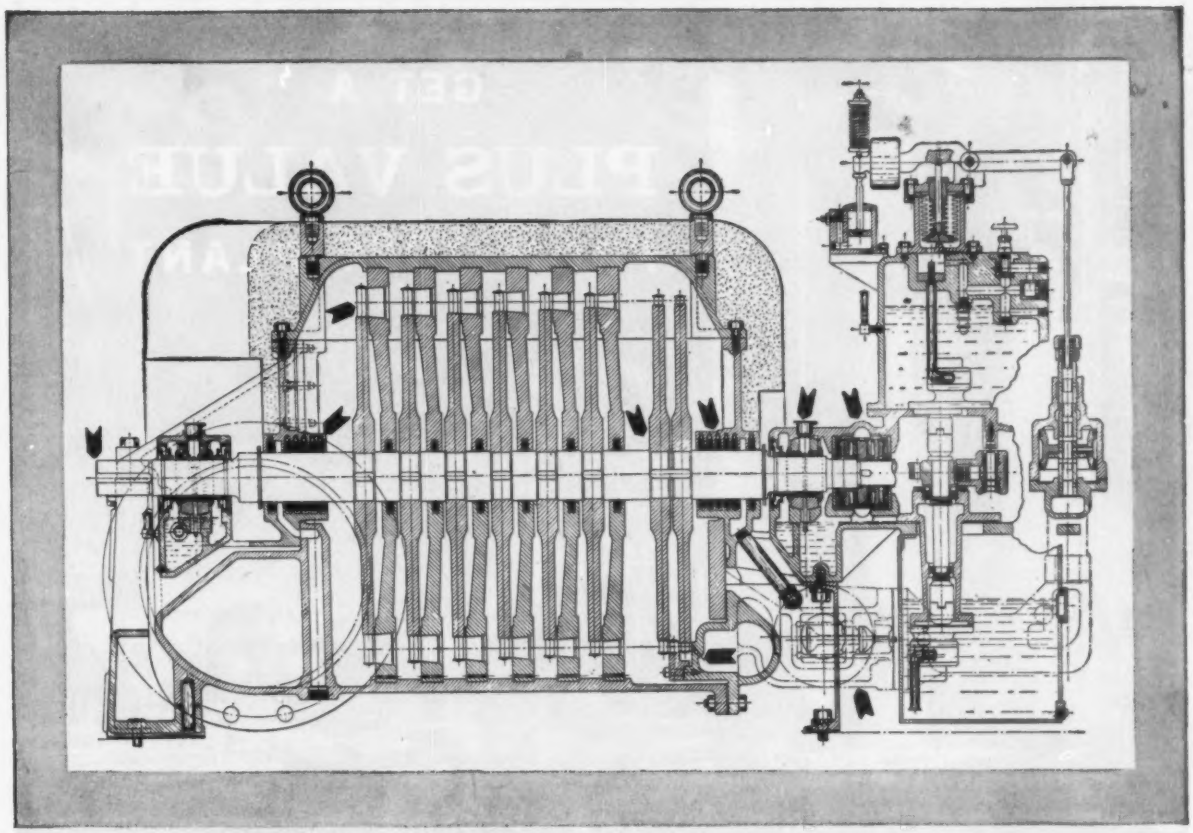
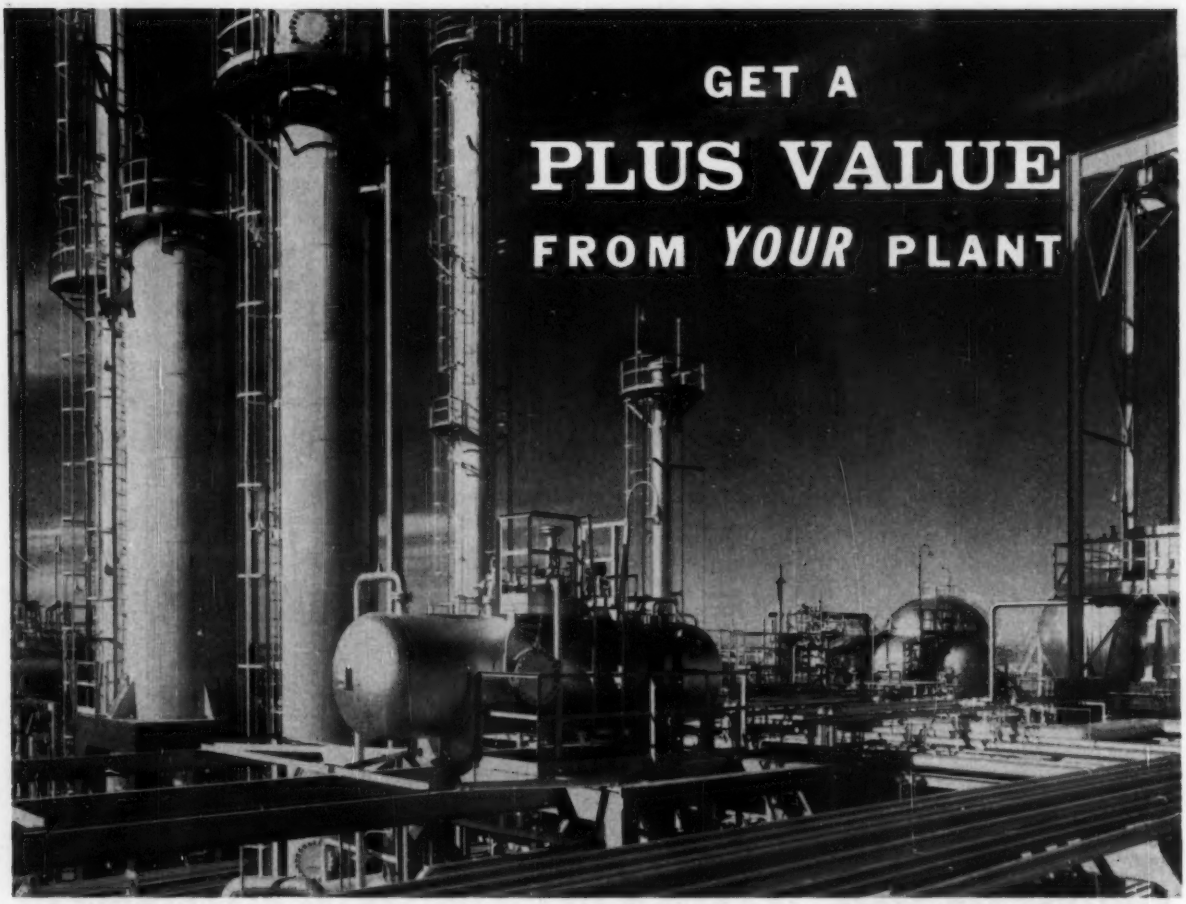


ANOTHER INSIDE STORY OF THE UNIVERSAL ACCEPTANCE OF MURRAY MULTI-STAGE TURBINES IN THE MECHANICAL DRIVE FIELD

- Husky accurately machined shaft.
- Discs shrunk and keyed in place.
- Stainless steel nozzles and blading throughout.
- Spherical seated sleeve bearings.
- Kingsbury thrust bearing.
- Center line support.
- Carbon ring gland seals.
- Double seated balanced governor valve — stellited.
- Choice of speed governors from simple mechanical type to precision oil relay.
- Bolt type overspeed trip governor.
- Steam conditions to 600 PSIG and 750°F.
- Condensing or non-condensing.

Our nearest representative will gladly help you solve your mechanical drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

★ ★ **Murray Turbines** ★ ★



You always get a *plus value* in engineering ability and construction skill when your plant is planned and built by The REFINERY ENGINEERING Company. TRECO has never been guided by *minimum* requirements on any job, large or small.

Remember the *plus value* TRECO offers when you plan your next plant.

1942 TRECO 1957
15th ANNIVERSARY

A brochure showing work done by TRECO is available. A copy will be mailed you promptly upon request on your company's letterhead.

A DIVISION of VITRO CORPORATION of AMERICA

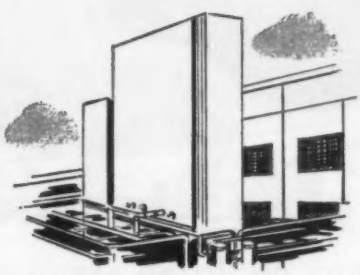
The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

CO

Now you can produce CO more efficiently, simply, at lower cost

LONG THE BANE OF many chemical processes, carbon monoxide has suddenly become one of the most valuable raw materials of the ever-growing plastics and allied industries. More important still is its method of production by low-temperature gas separation, in which techniques perfected by Air Liquide during the past 50 years have resulted in unprecedented efficiency, tremendous economies and maximum purity.



Leading this highly specialized field in the United States, Air Liquide low-temperature gas separation plants, the first to be built in this country for the production of pure CO, have recently been completed in four widely separated locations, and a fifth is under construction.

Our entire technical and manufacturing staff, including design, process, project and mechanical engineers, backed by a half century of world-wide experience, is at your service to assist you in applying low-temperature technology to your particular needs — whether your product requirements are carbon monoxide, oxygen, nitrogen, hydrogen or other gases, or a solution to purification problems.

We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components especially fitted to your needs. Write today for complete technical information on our CO plants.

In Canada:
L'AIR LIQUIDE,
1111 Beaver Hall Hill,
Montreal, Que.

AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE — NEWEST IN DESIGN

529 CHRYSLER BUILDING, NEW YORK 17, N. Y.

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Let Harshaw Catalysts do a GIANT'S work for you

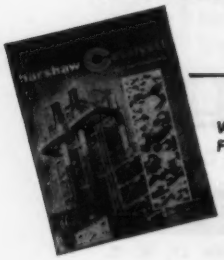
Harshaw Catalysts do a giant's work and Harshaw produces catalysts in giant quantities—carloads every week. A letter or phone call will put our 20 years' experience and acres of production and research facilities to work for you.

PREFORMED CATALYSTS
to fit special process requirements
Hydroforming
Cyclization
Oxidation
Dehydrogenation
Dehydration
Desulphurization
Alkylation
Isomerization
Hydrogenation

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.



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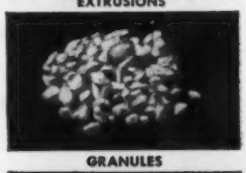
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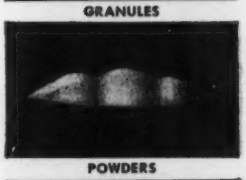
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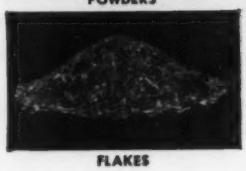
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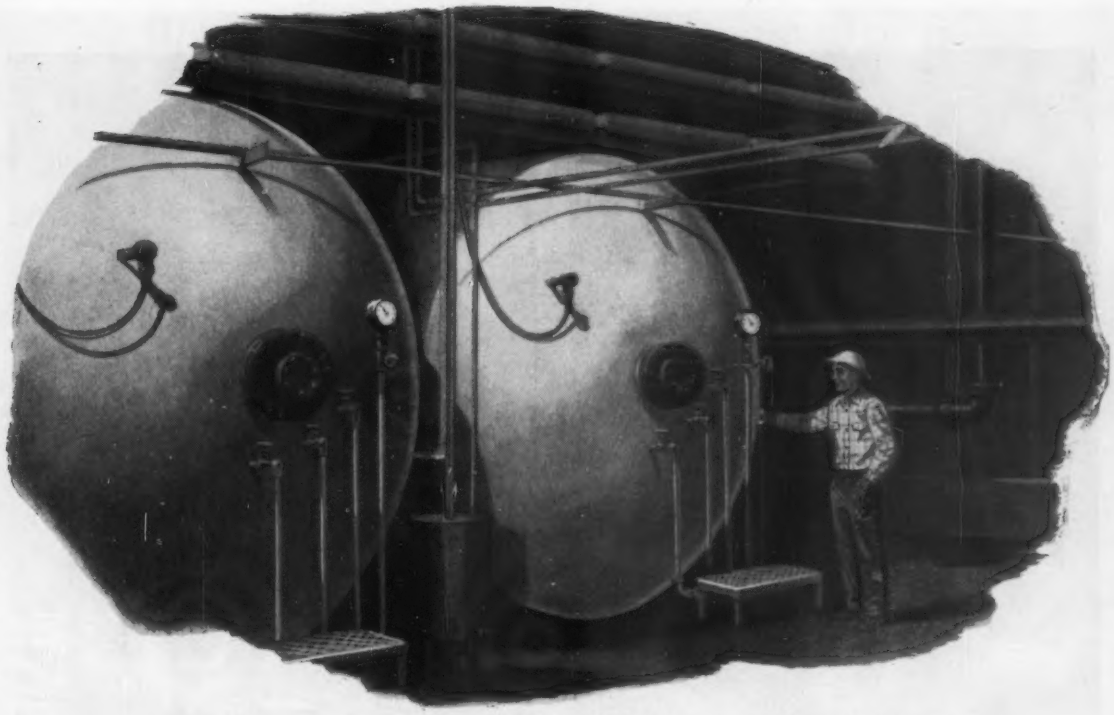


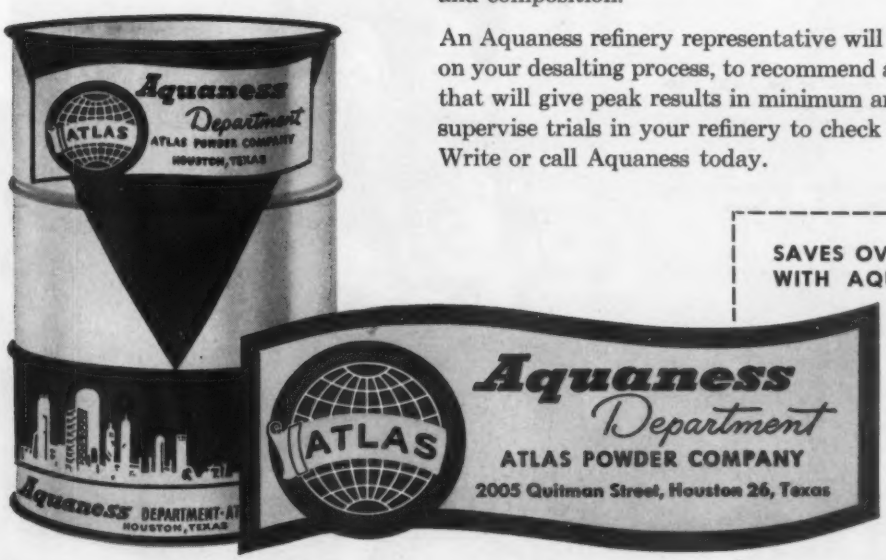
cut chemical costs in half

with Aquaness desalting compounds

You'll save money, because Aquaness materials are concentrated. They're more economical to use, to ship, to store.

You'll eliminate trouble, because Aquaness materials work with a wide range of crudes. You don't need to switch chemicals or adjust feed rate when incoming crude varies in gravity and composition.

An Aquaness refinery representative will be glad to consult on your desalting process, to recommend an Aquaness compound that will give peak results in minimum amounts, and to supervise trials in your refinery to check performance. Write or call Aquaness today.



SAVES OVER $10,000 PER YEAR WITH AQUANESS COMPOUNDS

A leading refinery processing 8 different crudes at a total charge of 30,000 bbl/day has cut its desalting chemical cost by 52% by changing to concentrated Aquaness compound. Chemical savings amount to more than $10,000 per year.

Chemicals for Refining, Gasoline Plants and Oil Transportation

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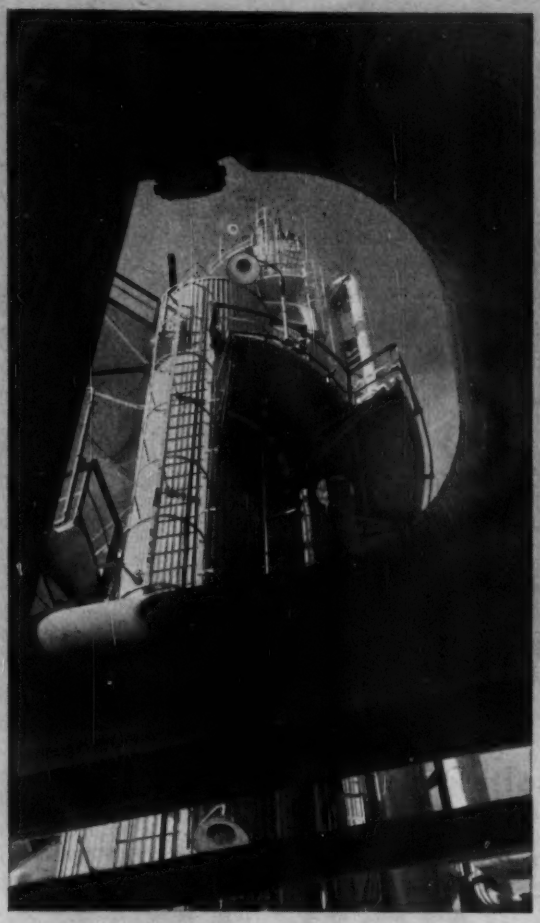

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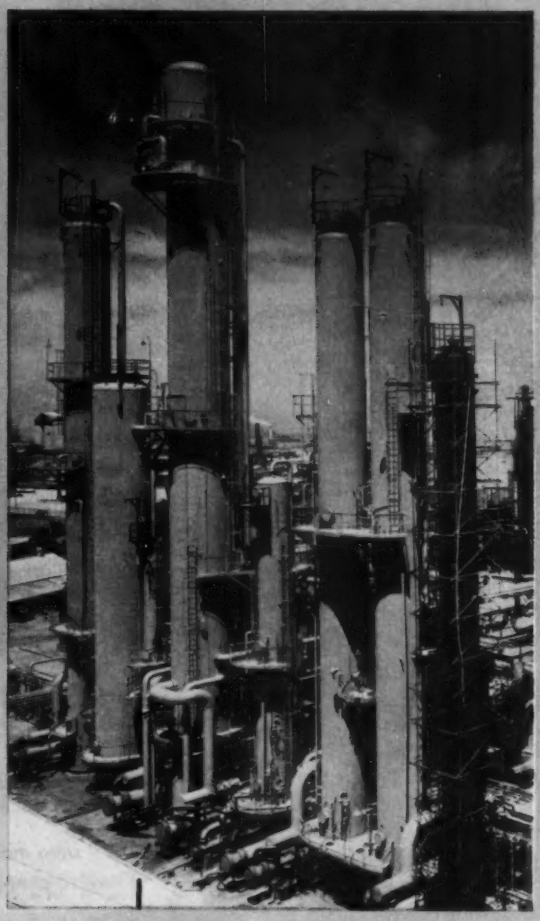
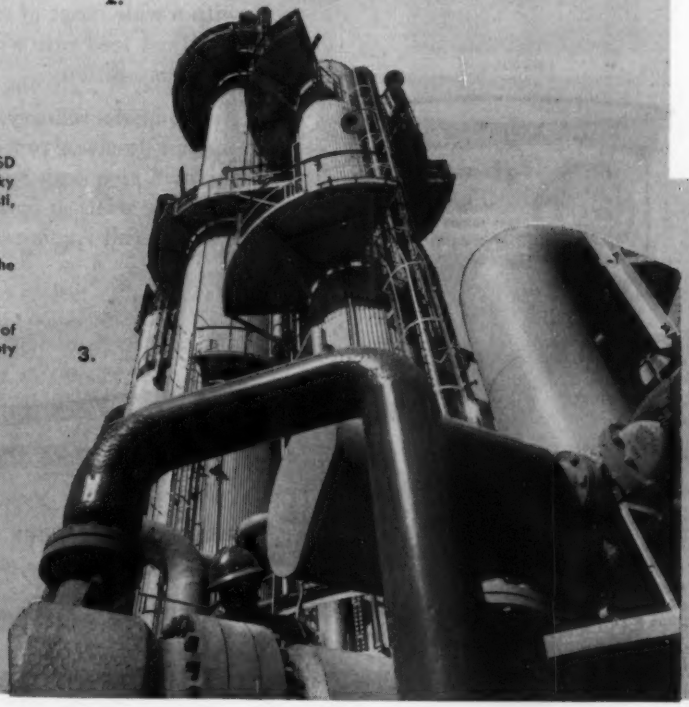


2.

1. The solvent extraction columns of the 5,000 B/SD Udex unit are dramatically framed against the sky at the Delhi-Taylor Oil Corporation's Corpus Christi, Texas, refinery.

2. Shown here is the Udex unit in operation at the Delhi-Taylor refinery, Corpus Christi, Texas.

3. Though highly functional the extraction towers of the 5,000 B/SD Udex unit add an element of beauty at the Delhi-Taylor refinery.



3.

For more data on advertised products, use Readers' Service Cards, last page.

Platforming—Udex Units Open New Petrochemical Market To Delhi-Taylor

By F. P. Sewell
Vice President
Delhi-Taylor Oil Corporation
Corpus Christi, Texas

F. P. Sewell

Customer confidence, plus our own confidence in the growth potential of petrochemicals prompted us recently to enter this field. Our investigation, some time before the spring of 1956, indicated a substantial market for benzene to be used in synthetic chemicals. We decided to build an installation for the production of aromatics. We needed a process that could smoothly fit into our operation, a process that could economically produce aromatics of highest purity. After carefully examining the available processes, we found that the Udex process efficiently and at low cost extracts benzene, toluene and xylenes simultaneously from a Platformate which we could produce in our existing Platforming unit. We were confident the Udex process was our answer.

The next step was a meeting with engineers of Universal Oil Products Company in the spring of 1956 to determine the design for the new Udex unit. With the design fitted to serve our requirements the only remaining problem was the time necessary to complete the unit. Accordingly, purchasing and preliminary expediting of the major components were left to UOP. This assured us of the fastest possible delivery of these items. We are indeed pleased that in just over a year, from design to on stream, we were able to keep our promise to our customers, supplying benzene exceeding nitration-grade specification. With successful aromatic production and a marketing program under way, we were also able to achieve our basic objective, "product diversification."

Increases Value of Products

A 5,000 B/SD Platformer, on stream since 1953, was designed originally with provisions to facilitate its change-over to the production of a Platformate best suited to aromatic extraction. Since 1953 this Platformer has been producing a Platformate used to up-grade the octane number of our pool gasoline. Thus, through converting our production to aromatics we were able to raise, substantially, the value of our products from this unit.

During the planning stages of the Udex unit with UOP we also launched into yet another phase of our expansion program. As a custom refiner we sell motor gasoline in quantity to several customers. We keenly feel a sense of responsibility to maintain the high octane level and quality of our pool gasoline consistent with the demands of today's high compression engines. To this end we made arrangements with UOP to install another Platformer, a 10,400 B/SD unit, and a 10,400 B/SD Unifining* unit. The Platformate produced in this unit, on stream in May, 1957, is used as a high octane blending component in our pool motor gasoline.

These units are also used to provide additional Udex feed stocks. This is done by charging a select feed to the Platformer-Unifiner in a blocked-out operation. The resulting Platformate is charged incrementally to the Udex unit. This Platformer is our third, and the second Platforming unit at the Corpus Christi refinery. The efficient operation and high quality of products from our first two Platformers influenced our decision to install this third Platformer.

Aromatic Production

Production of aromatics at the moment is approximately 2,000 B/SD. The growing benzene market includes application in the manufacture of phenol and styrene plastics, synthetic fibers, agricultural chemicals, detergents, pharmaceuticals and other chemicals. Toluene and xylenes are sold as chemical raw materials and solvents. Toluene finds some use also as a blending agent in aviation gasoline and as a "super-premium" gasoline blending stock.

Production of benzene, toluene and xylenes from UOP Platforming® and Udex® units provides Delhi-Taylor profitable product diversification

designed, engineered and licensed by

UOP UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

More Than Forty Years Of Leadership In Petroleum Refining Technology

* Trademark of Universal Oil Products Company

For more data on advertised products, use Readers' Service Cards, last page.

WORLD'S MOST MODERN REFINERY — Tidewater Oil Company's new Delaware Refinery, 15 miles south of Wilmington, represents the most advanced thinking of refinery engineers and technologists.

LOW-COST WATER AND SOLIDS REMOVAL—A BASIC FOR MANY REFINING AND PETROCHEMICAL PROCESSES

Separator/Filters have multiple uses

Applications — In today's modern refineries and petrochemical plants, many processes are highly dependent upon low-cost removal of water and solid contaminants. Fram-Warner Lewis water separator/filters are extensively employed in process applications because their use provides the benefits of improved feed preparation, reduction in catalyst consumption, lower corrosion rates, and water free products.

Products Handled — LPG, gasoline, naphtha, distillate, gas oil, aromatics.

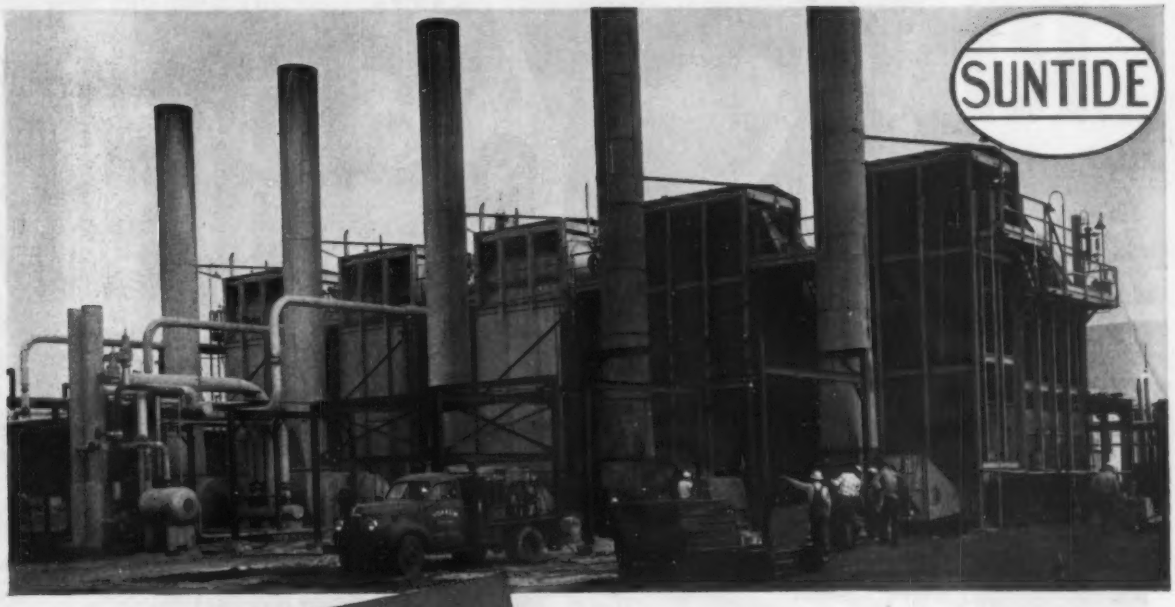
Special Uses—Feed stocks, treated and water-washed products, finished products to storage.

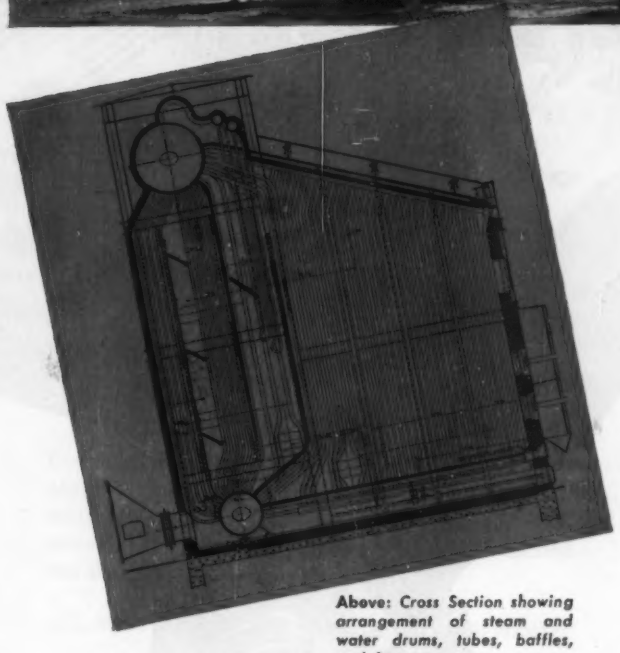
Description — Fram-Warner Lewis separator/filters offer a flexibility of design to meet a variety of process applications — Vertical single stage, horizontal single stage, horizontal two stage separator/filters with entrained water removal efficiencies of 90 to 100% and filtration efficiency down to 5 microns particle size. Engineering design and pressure vessel fabrication facilities at Warner Lewis Tulsa plant are always available to handle special problems to customer specifications. Let proven experience in the field in countless process applications help you.

For Further Information — Write Process Section Warner Lewis Company, Division of Fram Corporation, Box 3096, Tulsa, Oklahoma, for Process Manual on water separators/filters. Warner Lewis representatives are located throughout the United States and Canada and they will be glad to contact plant processing and operating personnel.

Vogt STEAM GENERATORS

at SUNTIDE REFINING COMPANY
Viola, Texas





Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

EFFICIENCY AND ECONOMY PROVED BY FIRST 3 UNITS . . .

2 MORE ADDED!

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BPR

OTHER VOGT PRODUCTS

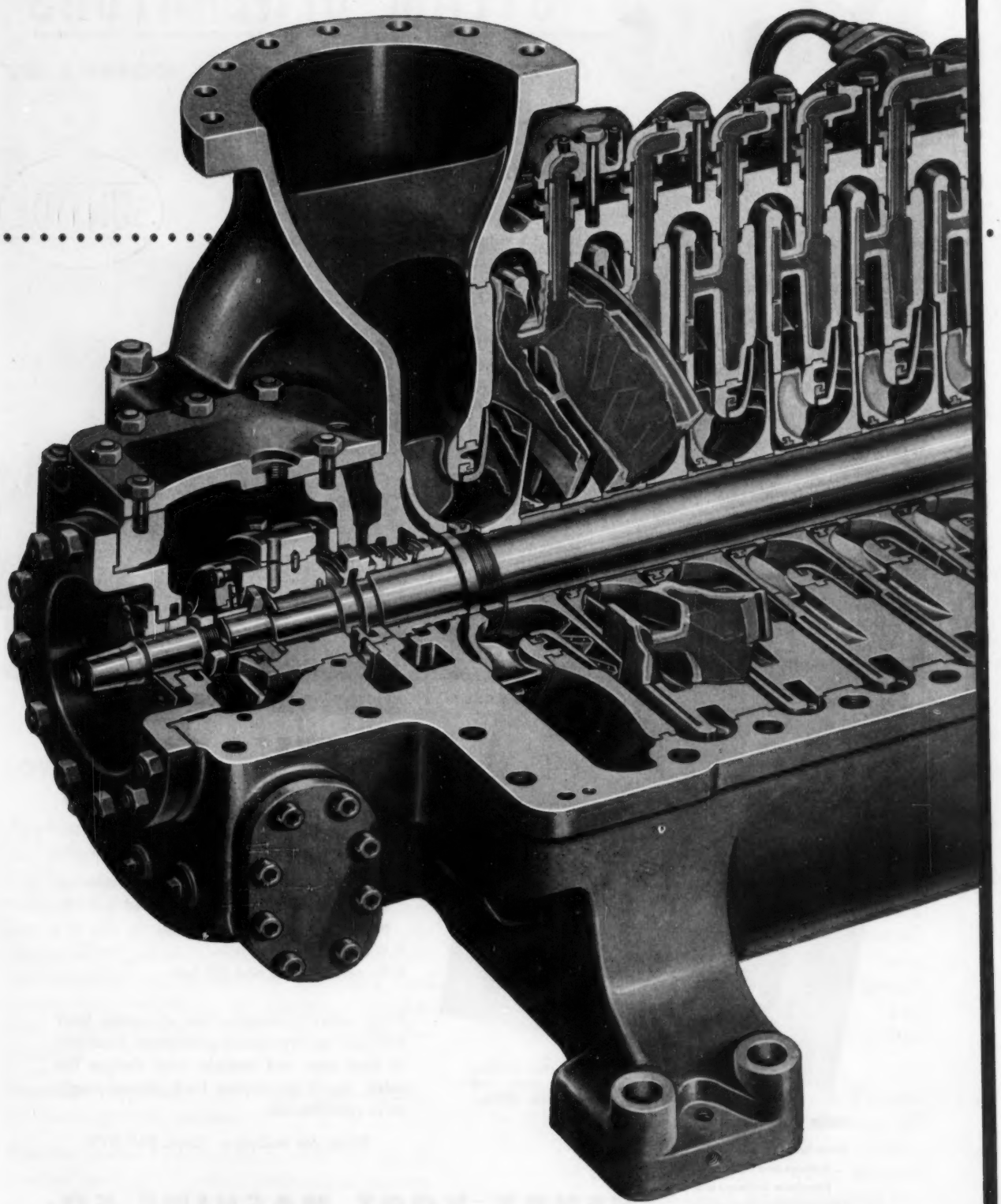
Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.

Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

For more data on advertised products, use Readers' Service Cards, last page.



CLARK

Diaphragm Cooling

- **Minimizes polymer formation**
- **Slashes horsepower requirements**
- **Greater safety handling hazardous gases**
- **Reduces capital investment**

Clark double-wall diaphragm cooling is the simplest, safest, and most effective way to intercool a multi-stage centrifugal compressor. Furthermore, polymer formation is minimized in the compressing of unsaturated hydrocarbon gases by the use of diaphragm cooling. It is a simple, economical method of maintaining gas temperature at the desired level in the capacity range of 1,000-30,000 CFM.

Power savings are an additional benefit of diaphragm cooling. The savings range from 20% on 15 molecular weight vacuum gas compressing applications to 5% for 110 psig. air compressors. Reduced installation and operating costs result.

Minimum capital investment is realized another way. Applications involving high compression ratios such as gas recovery and 120 psig. or less air compressors can be handled in a single case.

Diaphragm cooling also assures maximum safety when compressing oxygen, acetylene, and other difficult gases. Internal surfaces are always cool. Danger from potential hot spots is highly remote.

Clark builds a complete line of multi-stage centrifugal compressors and in many instances a gas turbine to drive them. Your nearest Clark representative has all the facts.

CLARK BROS. CO. OLEAN, N. Y.

One of the Dresser Industries

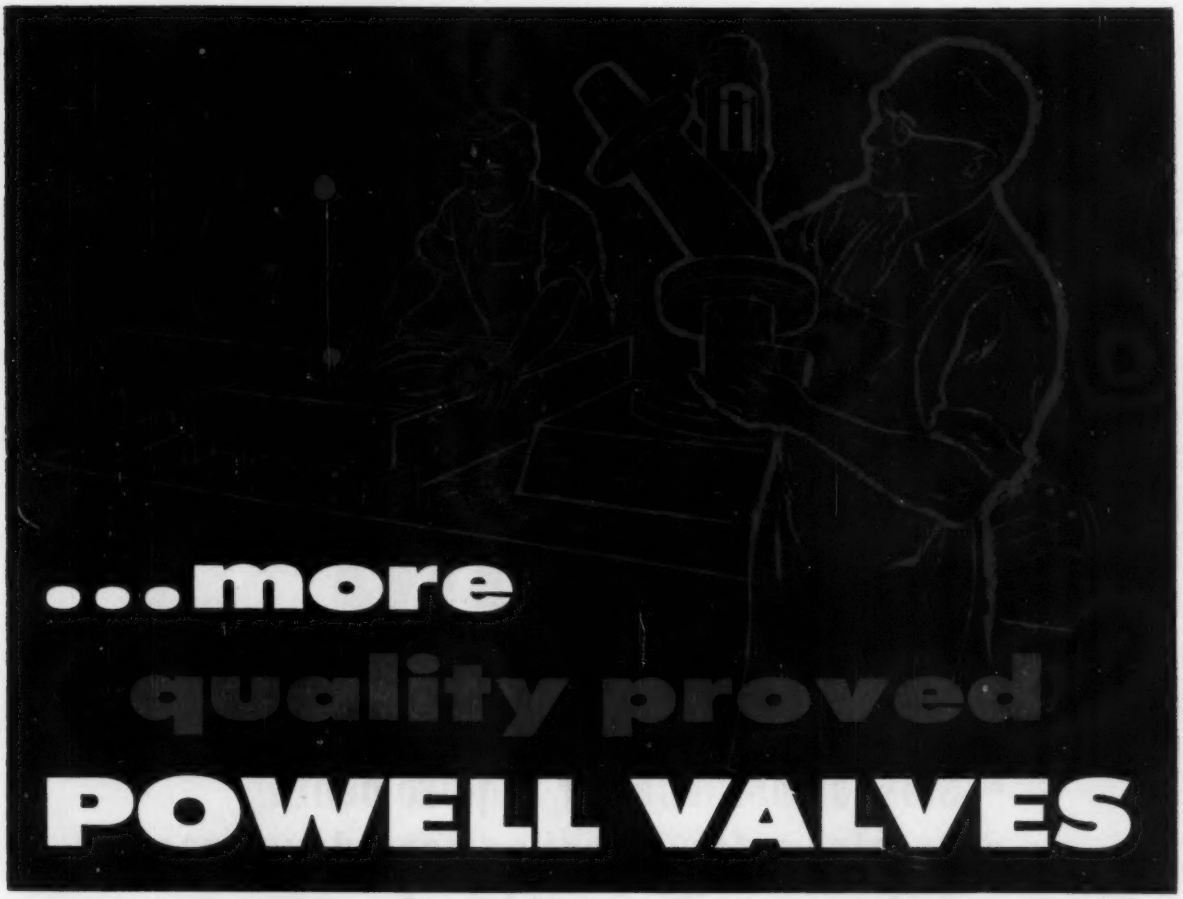
Offices in Principal Cities Throughout the World

CLARK

Centrifugal Compressors

Gas Turbines

For more data on advertised products, use Readers' Service Cards, last page.



...more quality proved POWELL VALVES

Fig. 2201—175-Pound W.O.G. Semi-Steel Lubricated Plug Valve.

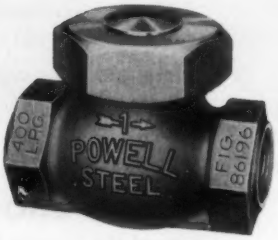


Fig. 86196—Steel "LPG" Horizontal Lift Check Valve for 400 W.O.G.

Fig. 375—Bronze Gate Valve for 200 Pounds W.S.P. Union Bonnet. Inside Screw Rising Stem.

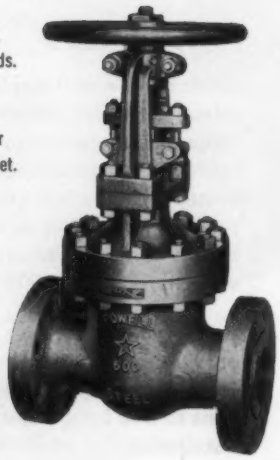


Fig. 6003—Steel O.S.&Y. Gate Valve for 600 Pounds.

for quality-crafted flow control

Ask your Powell Valve Distributor for the facts about quality-proved bronze, iron, steel and corrosion-resistant valves. Whatever your flow control problem, there's a Powell Valve to solve it.

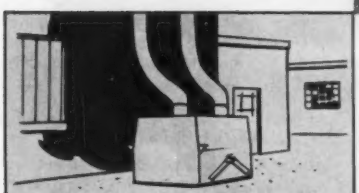
THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

For more data on advertised products, use Readers' Service Cards, last page.

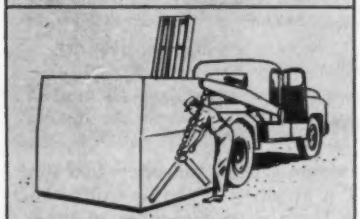
TEXACO
REG. T. M.

The TEXAS COMPANY "CONTAINERIZES" Waste as It Accumulates

Port Arthur Refinery "Containerizes" Waste, Rubbish and Liquids at Many Accumulation Points . . . Hauls and Dumps Them With Dempster-Dumpsters



WASTE IS CONTAINERIZED . . .



. . . PICKED UP . . .

. . . HAULED . . .

. . . AND DUMPED . . .

Dempster-Dumpster Waste Disposal System Serves Leading Refineries & Chemical Plants

Waste disposal and plant cleanliness can no longer be efficiently maintained by wheelbarrows, cans, carts, or bins. Shoveling, re-handling and on-site dumping have been replaced in leading plants by "Containerization" of waste as it accumulates. By placing clean, big-capacity Dempster-Dumpster containers at accumulation points, you can save thousands of dollars annually and enjoy improved plant cleanliness.

The one-man, one-truck Dempster-Dumpster can service over a hundred accumulation points, picking up, hauling and emptying the containers on a planned shuttle schedule. Chemical plants and refineries customarily amortize their equipment investments in 18 months or less. Write today for the free booklet, below.

FREE: Write Today for Your Copy of
"How to Reduce Waste Disposal Costs."

DEMPSTER BROTHERS, Knoxville 17, Tenn., DEPT. PR-12

THE DEMPSTER DUMPSTER® SYSTEM

To: Dempster Brothers, Dept. PR-12
Knoxville, Tennessee

Please Send Without Obligation Your Booklet, "How to Reduce Waste Disposal Costs."

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

CITY..... STATE.....

For more data on advertised products, use Readers' Service Cards, last page.

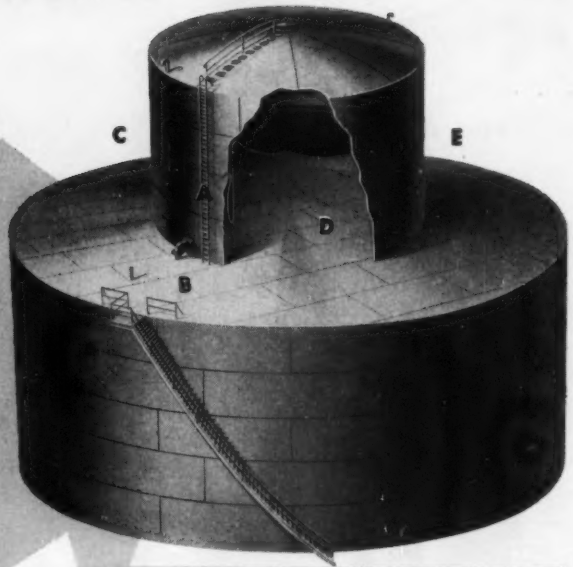
THE HAMMOND DIALIFT

the only membrane type conservation tank

... with full-rated vapor and product capacity at all times

... with a membrane that cannot come in contact with product

... with vapor space that can be isolated for inspection and maintenance without taking tank out of service.



Principle of the Hammond Dialift

A—DIALIFT DIAPHRAGM rises and falls to accommodate expanding and contracting vapor.

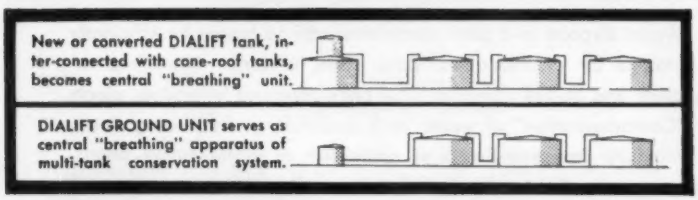
B—Vapor passes to and from tank and DIALIFT through simple elbow connection.

C—DIALIFT and tank have full-rated capacity.

D—Membrane can't come in contact with product.

E—DIALIFT can be isolated for maintenance and inspection, product tank stays in service.

The most efficient and economical vapor conservation system for new or old tanks.


New or converted DIALIFT tank, inter-connected with cone-roof tanks, becomes central "breathing" unit.
DIALIFT GROUND UNIT serves as central "breathing" apparatus of multi-tank conservation system.

THE HAMMOND DIALIFT consists of a gas-tight Vulcalock membrane attached to the inside periphery of a cylindrical metal housing to become a "breathing" apparatus to accommodate the expanding and contracting vapor as developed in product storage tanks. The DIALIFT can be used as a single conservation unit by being attached to the roof of a product storage tank or as a central "breathing" system by being manifolded to a number of product storage tanks. There are two forms of installation:—Ground type manifolded to a number of tanks to form a conservation system and integrated type whereby the DIALIFT is attached to the roof of a tank for vapor conservation for one or a number of tanks. The DIALIFT is completely isolated from the product storage tank. Vapor passes between the tank and DIALIFT through a vaporline connection. It is easy to convert old cone roof tanks to efficient vapor-saving DIALIFT installations by attaching a DIALIFT housing with membrane to the roof of the old tank and connecting the vaporline between the tank and DIALIFT.

THE HAMMOND DIALIFT ELIMINATES BREATHING LOSS AND REDUCES FILLING LOSS

Write for dialift catalog 55DL

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

HAMONDTANK

The Mail Box . . .

Qualification Cited

To The Editor:

In the article "How Metals Behave at Low Temperatures" by Prof. Franz R. Brotzen (October, 1957, PETROLEUM REFINER) the author has ably presented many of the factors which influence metal properties at sub-atmospheric temperatures. This one point, however, seems open to question: "For very low temperatures, i.e., below —200F, steels of the 2300, 4100, 4300, 8600 and 8700 series are recommended."

While it is true that tensile test ductility of these steels may be appreciable at low temperatures and thus justify some applications below —200F, use of certain of the materials in critical or hazardous service at these temperature levels is not recommended generally. One need only recall that a 3½ percent nickel steel (2300 series) was employed for the liquefied natural gas storage tanks in the disastrous Cleveland fire late in 1944.

The author is quite accurate in his contention that "For severe service conditions the transition temperature, determined by Charpy test, should be as low as possible." However, impact tests on some of the aforementioned steels at —200F yield very low values. This is especially true when the materials are heat treated as heavy and/or irregular sections so that the best structural conditions are not obtainable. It would seem that the author's statement relative to the use of low alloy steels below —200F requires some qualification.

E. A. Sticha
Crane Company
Chicago

Author Replies

Mr. Sticha has a very important point. My statement concerning the recommendation of steels of the 2300, 4100, 4300, 8600 and 8700 series should not be construed as an unqualified one. Indeed, a look at Figure 4 in the article reveals that, depending on the microstructure, a steel of the 8700 series may have very low-temperature impact properties. In addition to composition, many qualifications, such as microstructure, stress state, and grain size must be taken into consideration before an intelligent choice of material for severe low-temperature conditions can be made. The importance of this point, already made in the aforementioned article cannot be over-emphasized.

Franz R. Brotzen
The Rice Institute
Houston

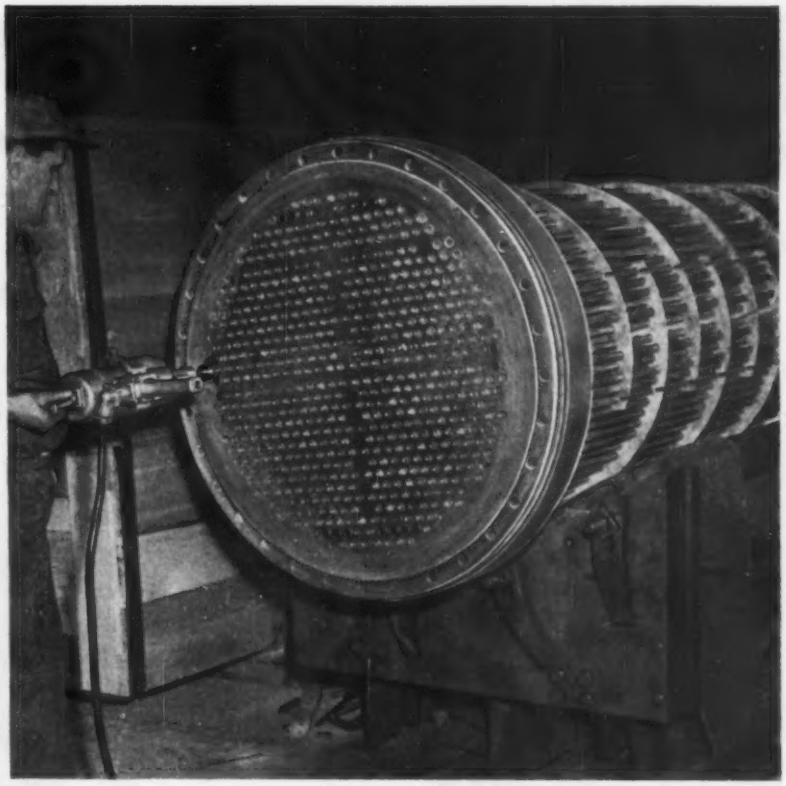
Error in Figure

To The Editor:

In your September, 1957 issue in the article entitled "How to Size Rotating Disc Contactors", by G. H. Reman the capacity correlation in Figure 2 contains an error. The ordinate of the figure gives the product of the velocity of continuous and dispersed phases whereas, I believe, the correct form is the sum of these flows, divided of course, by C_R.

H. A. Wistrich
Shell Oil Co.
New York

Editor's Note—This error, contained in the submitted original of Figure 2, we gladly correct.



Tricky assembly job handled with ease...at Downingtown

Specs said: Roll type 329 stainless tubes into type 316 and 304 tube sheets. A tricky problem, since the 329 tubes are 15-20 points harder on the Rockwell B scale than the 304 and 316 tube sheets.

What's more, an alert suggestion saved our customer the cost of a test shell, by utilizing the annulus created by the specified double tube sheet construction.

Design Pressure: Shell —125 psi at 300° F.
Tubes— 75 psi at 300° F.
Hydrostatic Test Pressure: 150 psi
Construction: Per ASME Code, Para. U-69...Customer Inspected
Tubes: 608 Stainless Steel Tubes, Type 329 (Carpenter #7MO)
¾" O.D. x 16 ga. x 15' 9" L.
Outer Tube Limit: 30⅝"...4 Pass
Floating Tube Sheets: Two—1½" and 2" thick...32¾" O.D.
Fixed Tube Sheets: Two—1¼" and 1¾" thick...38⅜" O.D.
Shell Side Tube Sheets: Stainless Steel, Type 304.
Tube Side Tube Sheets: Stainless Steel, Type 316.

Write for helpful heat exchanger design data—Bulletin HE.

Downingtown Iron Works, Inc.
151 Wallace Ave., Downingtown, Pennsylvania
division of PRESSED STEEL TANK COMPANY Milwaukee
Branch offices in principal cities
HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For more data on advertised products, use Readers' Service Cards, last page.

When choosing a premium power cable . . .

How much choice do you <u>really</u> have?

Cable may *look* alike—but you can find many differences in jackets and insulating compounds. And you want only the *best* cable for your operating conditions.

That's why it's important to choose your cable from a manufacturer who offers you a real choice of modern cable materials.

Full choice of insulating compounds

Only three major companies give you a choice of *either* oil-base or butyl-base insulation. Rome Cable is one of these three and offers a choice of Rozone A (butyl-base) and Rozone (oil-base) insulations.

And, in addition, Rome can offer you a *polyethylene* insulation for high voltages.

You can match your operating needs more closely with cable insulation that puts the emphasis on what you want most—resistance to heat, moisture, ozone cutting, or any combination of properties. You can be sure of this choice when the cable is made by Rome Cable.

Getting the right jacket

In modern jacket materials, too, the same kind of freedom works to your advantage. You get a choice, with Rome Cable, of Roseal (special flame-retardant polyethylene); Roprene (a Rome-developed neoprene compound for use with rubber insulations); Rolene (polyethylene); and several other high-quality jacketing compounds. Each has its own advantages, depending on your requirements.

Bring your cable problems to Rome

When you discuss your premium cable requirements with your Rome Cable representative, you can count on his recommending the *right* cable for you. No matter what type of cable you choose, take advantage of Rome's ability to offer you a *real* choice.

For more information on the choice you get with Rome's power cable, contact him now—or write to Department 713, Rome Cable Corporation, Rome, New York.

ROME CABLE

CORPORATION

For more data on advertised products, use Readers' Service Cards, last page.

A Quick Look at the Industry THIS MONTH

Refiners Look to Brighter '58 . . . Three factors pinched refining industry's pocketbook in '57—and all spelled "oversupply." Each will be taken to task in coming months.

- Last year's over-optimistic estimates of U. S. domestic demand helped create excessive product inventories. Look for '58 estimates to be more conservative—will range between 3.7 and 4 percent increase over '57 (for complete story see page 221).
- Most knotty oversupply problem arose from difficulties in adjusting output when Suez re-opened. There is little likelihood of another Suez crisis in '58.
- Small refiners' continuing problem of excessive imports will be lessened if . . . and when . . . government's voluntary program rolls into high gear.

In keeping with steady demand growth, API predicts refining capacity will increase from 9.08 million barrels per day on September 30, '57 to 9.30 million barrels on September 30, '58, up 220,000 barrels per day.

California's independent refiners have less encouraging outlook. They enter the new year with excessive product inventories, product prices which have yet to reflect earlier crude price hikes and the threat of heavy import shipments to the West Coast. Each of these factors is due for adjustment in coming months.

Independents Eye the Future . . . Factors needed to stabilize refining industry's economic status were major topics of discussion at November Independent Refiners' Association meeting. Call for action included curtailment of refinery runs to balance inventories—curb octane race to eliminate high consumer costs—expand government's voluntary import plan to include products.

Platinum Prices Show Downward Trend . . . Baker and Company trimmed platinum prices at mid-year from $93 to $84 per ounce—since then the precious metal has stayed in $84-$87 range, well below $105 per ounce high set earlier in '57. As catalyst competition increases, look for prices to go even lower.

Postings on Octane Race . . . Results of refiners' multi-billion dollar effort to meet new engine requirements in recent years are as follow: Average octane of regular gasoline has jumped from 80 in '47 to about 91 today. Premium increased from 86 in '47 to present range of 98 to 100-plus.

Here are reasons for the costly venture:

Engine compression ratios averaged only 6.5 in '47—are now 8.9. Average horsepower increased from 115 to 230 in same period. Some '58 cars will have up to 400 horsepower.

Petrochemicals Boom to Continue . . . With but one question mark—cost of raw materials—the petrochemicals industry will continue rapid expansion rate through '65. Here is what top researchers in the field reported at recent Houston meeting:

- Petrochemical production will increase more than 100 percent—from present 38 billion pounds per year to 85 billion pounds in '65.
- Now accounting for 26 percent of total chemical output, petrochemicals' share will be 40 percent in 10 years.

• Crude runs to stills for petrochemicals, now 42.6 million barrels per year (1.4 percent of total runs), will increase to 98.8 million barrels (2.3 percent of the total).

Only cloud in otherwise sunny picture: Octane race will offer serious competition for petrochemical raw materials. Unless petrochemicals offer better economic outlet for refiners, they will convert even more of their by-products into refinery fuel than at present.

Shoot More Guns . . . Plastics industry may be in for slice of nation's defense budget. Navy scientists report that after 10 years of research they have successfully developed an injection-molded plastic cartridge to hold propellant charge of 105-millimeter projectile.

Advantages: Easy to manufacture, lower freight charges for lighter materials.

Since cartridges are discarded with each round of ammunition fired, a lucrative new market awaits the plastics industry if final tests at Aberdeen Proving Ground prove favorable.

Quick Look at Washington . . . Head of Military Supply Agency wants military's exemption from "Buy American" Act to continue; however, he says future oil products purchased outside the country will be reduced to 10-15 percent of total purchases . . . **Predictions are that the oil industry** will lose most, if not all, its enthusiasm for the Harris-O'Hara natural gas bill if coal amendments are tacked on . . . **Antitrust probes of oil company operations** will gain momentum in '58, with big company ownership of major crude and products pipe lines as top targets . . . **Action is expected early in '58** to include West Coast in voluntary import cutbacks.

How to Save $3.9 Million . . . American Standards Association studies reveal that standardization of heat exchangers would result in annual savings of $3.9 million for the chemical industry alone. ASA is proposing project which would develop standards to cover shell and tube heat exchangers of following types: Fixed tube sheet with or without a shell expansion joint, U-tube, internal floating head, outside packed floating head and the kettle-type reboiler.

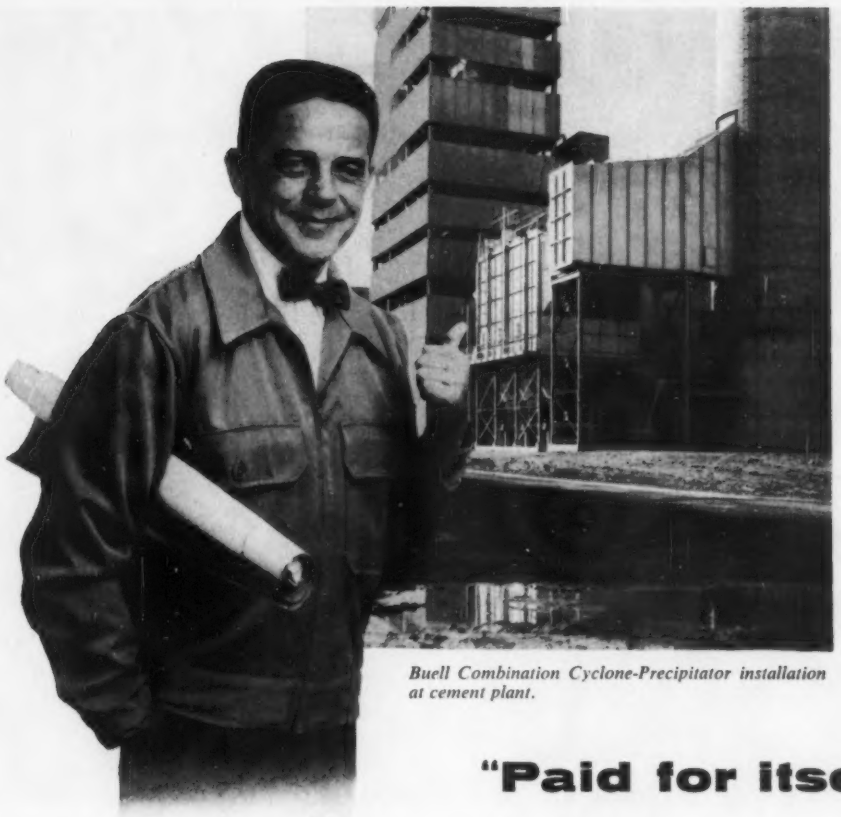
TV in the Refinery . . . Humble oil reports it is now using closed circuit television for furnace control at the company's Baytown refinery. Camera is focused on flame in a furnace, the flue generator which serves two hydroformers. The 14-inch screen which receives picture is in control room of one of the hydroformer units.

Alarm circuit in the television set gives audible warning if flame fails. System will shut down furnace after short delay unless operator pushes button and stops the automatic safety device.

New Trends in Radiation . . . Esso Research and Engineering announces purchase of the most powerful radiation source ever shipped for industry use—15,000 curies of radioactive cobalt.

Out of recent Atomic Industrial Forum in New York came some expert views on the usefulness of radiation. One speaker, Dr. Stockman of B. F. Goodrich Company, says costs are still too high. Much more research needed.

Experts also acknowledge that rapidly expanding radiation use is increasing possibility of accidents. To counter this trend, one company is offering industry a new service—decontamination squads. They are available to give technical advice in handling and cleanup of spilled radioactive materials.

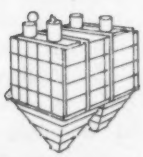


Buell Combination Cyclone-Precipitator installation at cement plant.

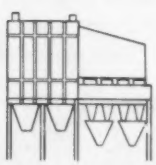
"Paid for itself!"

In nearly all cases, Buell dust or fume collection systems pay for themselves in just a few years. Buell "SF" Electric Precipitators provide extra collection efficiency *and* lower maintenance costs year after year, thanks to features like the exclusive high-emission, self-tensioning Spiral-ectrodes and unique Continuous Cycle Rapping. For specific information about dust collection efficiency and all three Buell systems, write for a copy of the booklet, "The Collection and Recovery of Industrial Dusts." Dept. 21L, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.

BUELL CYCLONE



"SF" ELECTRIC PRECIPITATOR



PRECIPITATOR-CYCLONE COMBINATION

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

THIS OIL BURNER NOZZLE contains no trace of sludge after 90 days of continuous operation with a heating oil containing Du Pont FOA-2. It had previously fouled every 30 days when operating with the same fuel without FOA-2.

CLEAN NOZZLES... one example

of the fuel system efficiency FOA-2 helps you provide

BY W. E. BETTONEY

When sludge-clogged nozzles and filter screens cause stoppage or reduce the efficiency of an oil heating system, the fuel often gets the blame. And the oil company may lose a customer . . . or lose profit because of the additional service required.

You can help prevent sludge from forming by simply adding Du Pont Fuel Oil Additive No. 2 (FOA-2) to your heating oil stocks at the refinery. The same additive will also reduce any build-up of sludge that may previously have formed. By reducing customer complaints, FOA-2 can help you protect your present business and also build a decided brand preference for your fuel oil.

Solubilizer and dispersant

FOA-2 delivers a high degree of protection against sludge because it is a solubilizer and dispersant as well as a stabilizer. It minimizes incompatibility between mixed fuels. Being nonmetallic, FOA-2 is ashless, too. This means that it burns completely, leaving no deposit to interfere with the operation of electrical controls.

To gain its advantages, try Du Pont FOA-2 in your own fuel oil stocks now. Ask any Petroleum Chemicals Division representative for free samples and the new descriptive booklet, or write E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

SEE DU PONT'S "SHOW OF THE MONTH" ON CBS

W. E. Bettoney is additives manager for the Du Pont Petroleum Chemicals Division's Eastern Region, with headquarters in New York City. He previously was assistant director of the Du Pont Petroleum Laboratory.

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. . . through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

Standardization—An Engineering Tool

A SET OF STANDARDS is as good a tool for an engineer as his slide rule. The only thing wrong is that many engineers have a tendency to forget this. D. F. Hollingsworth, principal standards engineer for du Pont pointed this out when he said that, "A dynamic standards program is one engineering tool which has been overlooked by a great many industries."

Taking these words into consideration, we should remember that just as certain engineering calculations have become accepted practice in industry, so can specific standards be universally accepted. The principal difference is that calculations can be proved and checked for accuracy through the use of mathematical tests. On the other hand, many standards are the product of man's thoughts and reasoning, and are, therefore, subject only to the test of time before the evidence is strong enough to warrant acceptance. Here we repeat that once this acceptance is achieved, the engineer has been handed another valuable tool.

Look at the following example and see how standards can affect costs. Some companies have a general engineering specification limiting all new centrifugal pumps to a fixed percentage of the maximum impeller. The idea is feasible in that it premits a future increase in capacity at a minimum cost. But often the supplier must increase the size of the pump and driver to meet the general specification. The increase in the first cost may be quite appreciable.

In this type of situation, standardization of pumps would help in two ways. First, the purchaser could easily figure what he is paying for the over-capacity. Second, there would be less incentive to build in the over-capacity if the purchaser knew that he could, if necessary, install a larger pump without changing the foundation and piping.

Over Standardization. Now what about over-standardization? Can you standardize to the point that incentives for unusual designs are stifled? There may be a tendency, when standardizing equipment, to request complete uniformity from the manufacturers. The result of such a program could be to limit designs to a narrow range and reduce competition to a few large companies who have the lowest shop cost. It could also remove all incentive to design special pumps with unusual characteristics applicable to one particular process problem.

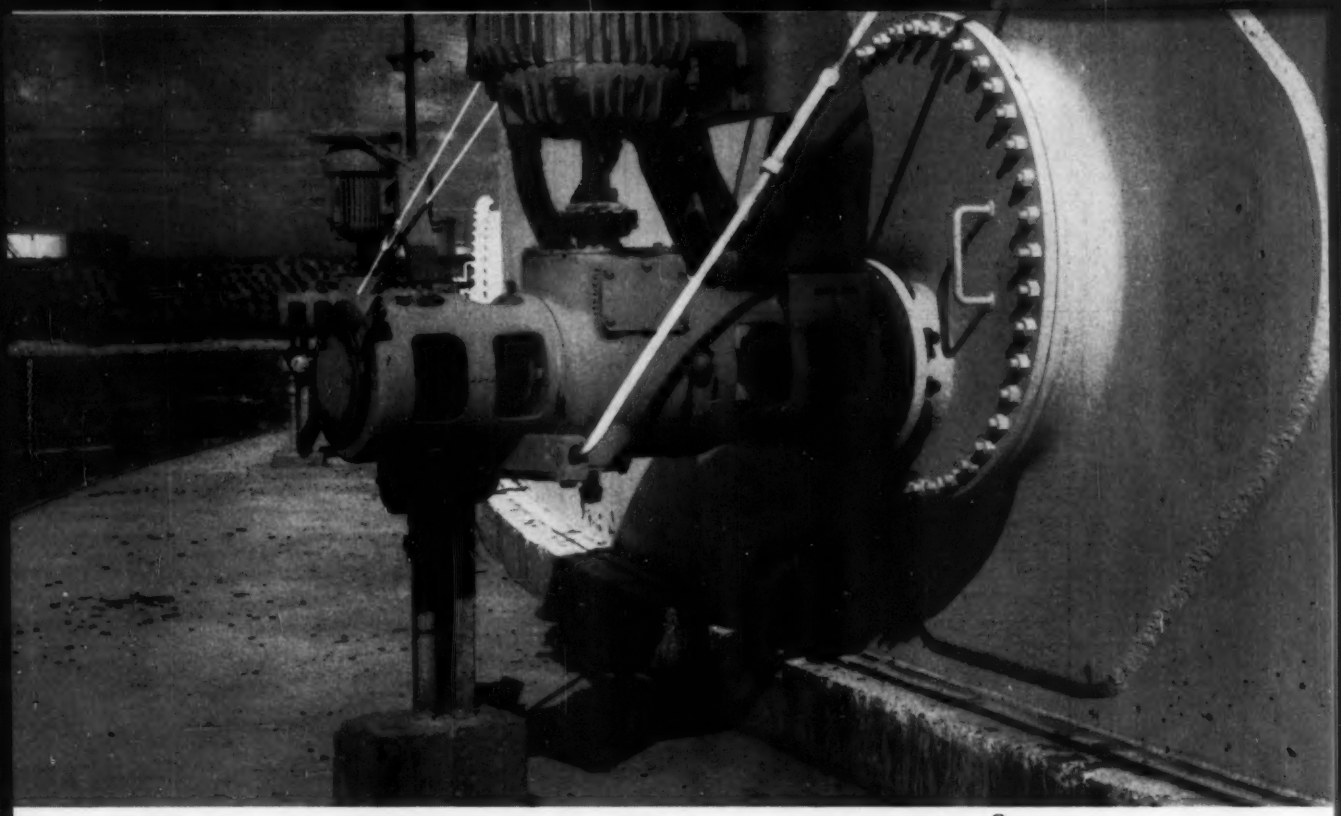
Here, we run into a natural role for equipment manufacturers; that of providing a sound check and balance to the standards proposed. Their special task will be to prevent over-standardization.

Another point which we should consider at this time is that some process equipment for refineries and petrochemical plants, does not lend itself to this type of reduction to uniform details. Absorption and extraction towers, catalytic crackers and mixers are good examples. On this apparatus, standardization should logically be concerned with performance rather than construction details.

Management. The high-energy propellant required for increasing standardization is "Management Interest." To illustrate the power of this force, look at the Manufacturing Chemists' Association which decided two years ago to see about working with ASA in determining where national standards would benefit the industry. Now, ASA has already announced that standards for pumps used in the chemical industry will be complete this year—practically a record breaking achievement. It is attributed to the fact that not only were engineers in the chemical industry interested, but also because chemical industry management was serious about wanting this standardization.

D. C. Brand, coordinator of standards for Monsanto, finds in the chemical industry "a move on the part of the individual companies to develop company standards programs. This serves two purposes and is a major asset in national activities because, (1) it orients the minds of engineers to thinking *standards* and therefore, provides the subjects and the bases for the projects to be undertaken, (2) it is a medium for obtaining and providing the cost data which is used to justify the projects and bring chemical industry management behind the projects, and (3) it prepares engineers to receive these standards and know how to use them to their greatest benefit."

Charles F. Bonilla, professor of chemical engineering, Columbia University, proposed to our editors that the following approach might be used to advance the standardization of equipment: "The AIChE, API, ASME, or other appropriate organization (ASA) could appoint several trial committees of manufacturer and user representatives in several lines of equipment (say pumps) to discuss and decide which dimensions or other features of their equipment line would be feasible, then profitable to standardize on, and to what extent. Their reports could be circulated widely for comments, and



No repacking . . . no drip, drip, drip!

How Sinclair stops leakage, saves work

blending 150,000 bbl. of product in 6 hours

You can see, in this unretouched picture, how clean and safe Sinclair Refining Company keeps this product-blending operation, with the help of LIGHTNIN Mixers.

Tanks like this at Sinclair's Houston refinery hold 150,000 bbl. of finished gasoline. LIGHTNIN Mixers, three to a tank, blend the gasoline to full uniformity in just six hours. Not a drop gets through the LIGHTNIN rotary shaft seals!

Never need repacking

Even more significant is the saving—in time and maintenance cost—that Sinclair makes with mechanical seal-equipped LIGHTNINs. They *never* need to be repacked, *never* need shaft seal adjustment!

These LIGHTNINs have been in operation one year. "Maintenance requirements? Negligible!" say Sinclair's refining people.

You can save as much as 60% on big tank mixer maintenance with this newest LIGHTNIN feature. Year after year, you get dependable sealing, end stuffing-box repacking and adjustment for good.

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And for the first time ever on side entering mixers, you can replace this seal *in a jiffy* if you ever have to!

Even under a full head of liquid in the tank, the seal-change job takes only minutes. No need to dismantle or remove the mixer from the tank. No special skill needed, either—it's a one-man, one-wrench job!

Available on all LIGHTNIN Side Entering Mixers, the LIGHTNIN seal cartridge is a unit assembly, easy to stock as a replacement or quickly obtainable in all sizes and materials for the simplest or toughest mixing conditions.

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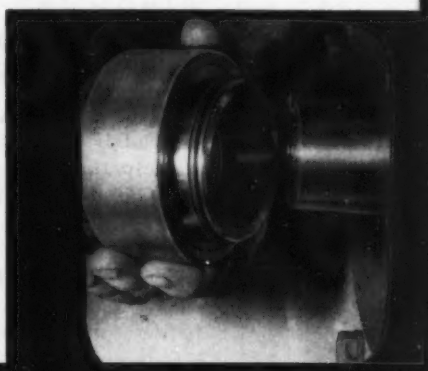

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- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
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- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-n Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.

if generally approved, presumably many manufacturers would follow suite. Of course, there would be the case of each manufacturer trying to get all of his standards accepted as the over-all standards, but this could probably be overcome for the mutual good of all."

Summary. Standards are tools just the same as the engineer's slide rule and thermodynamic formulas. He must, however, learn to use this tool and develop it if progress in reducing costs is expected. On the other hand, he must take care not to go too far and standardize everything in sight or he may kill individual design initiative.

The engineers must remind management that standards are necessary in order to provide the big push behind developing standards. Once this is done, management may want to develop company standards to enable engineers to become standard-conscious.

Everyone must work with manufacturers and other companies standards groups through societies, and their own personnel, to improve the role that standards must attain. This is the best road to the reduction of waste and duplication, and will provide the means to cutting cost and increasing profits.

Winter Demand Eases Woes

THE OUTLOOK is much brighter for the U. S. oil industry. Higher winter demand will benefit the industry during the next three months. This will afford not only an opportunity to work off surplus inventories which have been troublesome since mid-1957, but also some relief from recent low producing and refining levels.

To take full advantage of the situation, the industry will need to continue to hold production, imports, and refinery runs to reasonable levels. However, the gain in demand will be sufficient to permit some relief from recent exceptionally low producing and refining rates, and still correct excessive inventories.

A sizable gain in demand is foreseen. Total demand for U. S. crude and products should average slightly more than 10.5 million barrels daily during the next three months, December through February. That would be in contrast with an average of 8.8 million barrels per day during the past three months.

Much will depend on the weather. A very cold and prolonged winter would boost demand above the anticipated amount, while warmer than normal weather would cause consumption to fall below the estimated 10.5 million barrels per day.

The U. S. Bureau of Mines foresees an increase in crude runs to refinery stills to 8 million barrels per day during December. Refinery input rates during October averaged 7.715 million barrels a day, and only slightly more than 7.6 million daily during the first half of November. In view of the anticipated gain in demand, such an increase in refinery activity as expected in December would be moderate enough to permit reductions in surplus product inventories. If refinery runs exceed 8 million barrels daily during December, product stocks would become more troublesome instead of showing improvement.

Stocks of distillate fuel oil declined 1 million barrels during the four-week period ended November 15. On that date they totaled 171.5 million barrels, which was only 11 million barrels higher than they were a year earlier. It is significant that in mid-October, these inventories had been almost 20 million barrels higher than year-ago levels.

The latest inventory showed gasoline stocks totaling more than 182 million barrels, 10 million more than was in tanks a year before.

Some Applause For Shell

EVERY ONCE IN A WHILE, one of the large oil companies does something that will baffle you. They perform the unexpected like giving away a perfectly good patented process. What is their reasoning behind such a gift? Odd as it may seem, it is done in appreciation for the assistance which they have received from other oil companies.

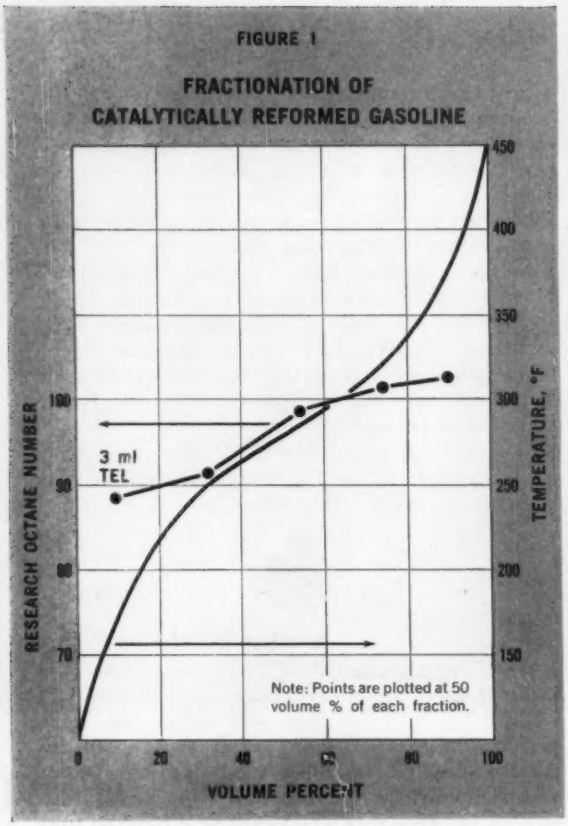
Shell Development Company spent four years developing a process to prevent hydrogen blistering of steel refinery equipment. Their patented process inhibits the penetration of atomic hydrogen into steel which is the culprit behind the problem of hydrogen blistering. A simplified version of the process is as follows: a small amount of air is enjected into the processing equipment, where conditions are conducive to hydrogen attack. Then, ammonia is added to maintain the proper alkalinity. The result is steel free of hydrogen blistering.

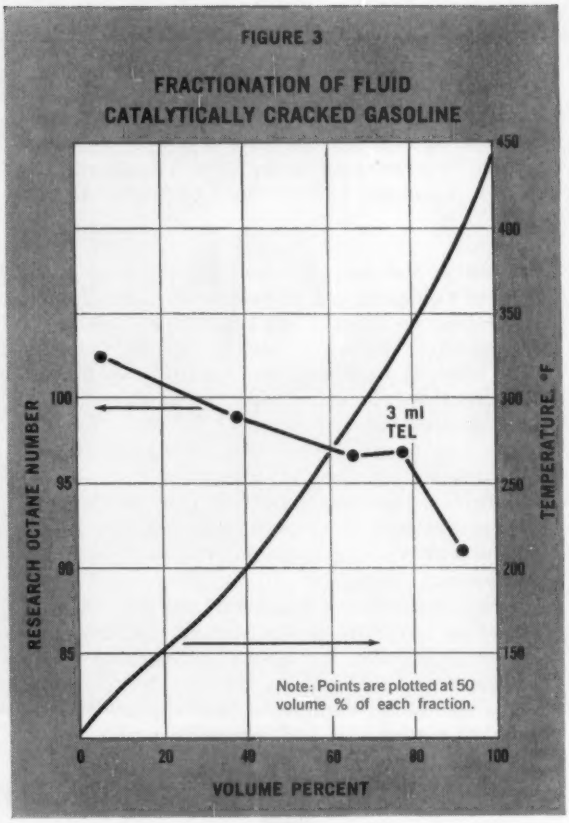
Shell is offering this process to industry through a royalty-free license. Shell said the grant has been made in consideration of the splendid assistance received from other branches of industry and as a contribution to industrial safety.

We say, "Hats off to Shell!" Once again, the petroleum industry shows its true colors.

We stand today at the gateway of what promises to be a great scientific revolution which will probably work a far greater change in our mode of living than the so-called industrial revolution has wrought in the past century or so. Most of us cannot even imagine the wonderful new devices and appliances that will become common-place necessities of our daily life in the next few decades . . . And all of this—experience has shown —will mean more jobs, more purchasing power, more leisure, and a more comfortable life for our people.

—BENJAMIN F. FAIRLESS
United States Steel Corporation





Ethyl's Octane Profiles Help Refiners Achieve More Economic Octane Numbers

FRACTIONATION of a reformate or cracked stock and an analysis of the cuts for octane and other inspection qualities by Ethyl Research Laboratories yield data that can be a very valuable tool for refiners in their continuous efforts to improve gasoline quality.

These data, referred to as "octane profiles," can be used as design bases for splitting both catalytically cracked and catalytically reformed gasolines. Such information is particularly valuable when refiners are planning how to use blending components most efficiently and economically in the production of 100 Research octane fuels.

Advantages of Splitting Reformate Are The Same As for Cracked Stock

Splitting catalytically cracked and catalytically reformed gasoline at the refinery into light and heavy fractions offers the following advantages:

1. no loss in yield

2. improves premium octane quality at low capital investment and low operating costs

3. segregates components of high anti-knock quality

4. balances premium and regular grade volatility

5. permits a milder reforming level for a given premium octane requirement with resulting yield advantage

of the fuel over the ranges fractionated.

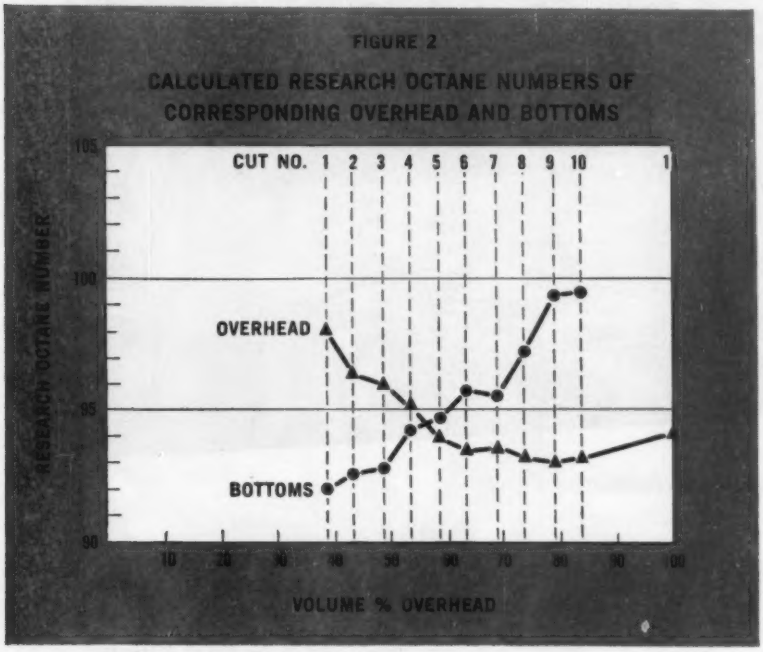
Engineers from Ethyl's Refinery Technology Group can recombine these cuts stepwise to develop a relationship as indicated below in Figure 2. This chart shows the quantity of stock that can be recombined to satisfy any given Research octane requirement.

A comparison of Figures 1 and 3 shows how catalytically cracked stocks can be handled in conjunction with catalytically reformed stocks to gain premium octane quality with balanced volatility.

The lower boiling portion of the catalytically cracked stock is combined with the higher boiling portion of the reformate. Then the remainders can be combined for use in regular grade fuel.

FIGURE 2

CALCULATED RESEARCH OCTANE NUMBERS OF CORRESPONDING OVERHEAD AND BOTTOMS



Product splitting can be a very economical way to gain additional octane quality in premium gasoline.

Reformate and Cracked Stock Cuts Can Be Recombined To Satisfy The Need for Higher Research Octane Number

Typical data for an octane profile of a reformate are shown in Figure 1.

Fractionation of the fuel that is under study into narrow cuts can be made on either a volume basis or a boiling range basis. Each cut then is subjected to a complete laboratory inspection in order to obtain the distribution of the properties

Blend 100 RON Fuels from 97 RON Base Stocks

Using data contained in an octane profile, and with the help of Ethyl Refinery Technologists, one refiner found he could produce a 100 RON blending stock (at 3.0 ml TEL/gal.) from 50 per cent of his 96 RON catalytic reformate (at 3.0 ml TEL/gal.).

Another refiner was shown that 45 per cent of his 97 RON catalytically cracked gasoline (at 3.0 ml TEL/gal.) rated in excess of 100 RON (at 3.0 ml TEL/gal.).

So, from stocks rating no higher than 97 RON, a refiner can selectively blend 100 RON gasoline yet satisfy volatility and other critical test requirements.

How Ethyl Research is helping you

Ethyl Research Laboratories in Detroit can help you evaluate the best cut points for your particular stocks.

The fractionating equipment available for this work includes 1-inch and 4-inch Oldershaw columns, 1-inch and 2-inch packed columns, and 1-barrel and 3-barrel stills.

These facilities for the close fractionation of gasoline and the services of Ethyl's Refinery Technology Group are available through your Ethyl Representative for many different kinds of studies.

These studies may include evaluation of reformer charge stocks, development of selective blending data for special boiling-range fuels, or any similar investigations you need.

ETHYL CORPORATION
New York 17, N. Y.

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RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
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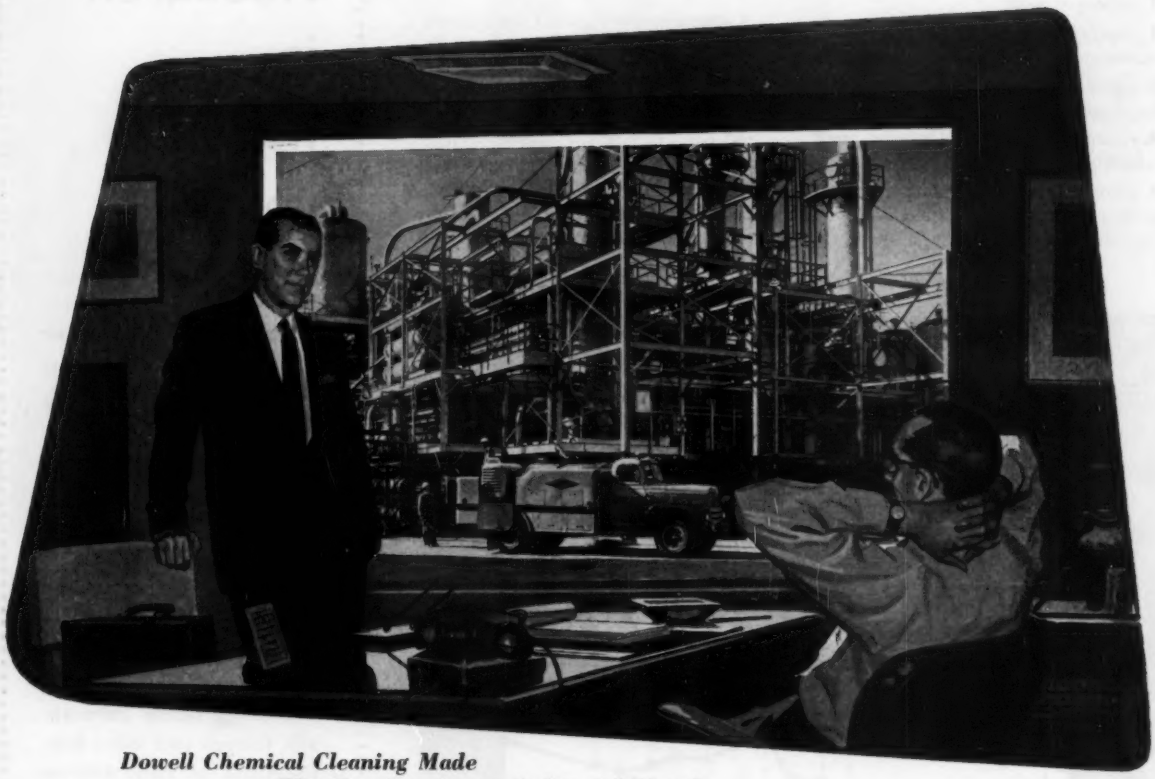


Dowell Chemical Cleaning Made This Possible for an Industrial Plant!

In 1954 an East Coast plant employed Dowell Chemical Cleaning Service on a limited basis. The results were encouraging.

In 1955 the same company expanded its use of chemical cleaning. The results were startling. More throughput, less down time, and greater overall plant efficiency effected nearly a *$250,000.00 saving!*

In 1956 the program was continued. The result: still more savings. Eventually, chemical cleaning on a continuing year-around basis is expected to effect savings of from $300,000.00 to $500,000.00 annually.

This case history is about an oil refinery. However, Dowell has eye-opening performance data to show you in almost any industry.

Dowell engineers are experts in the use of solvents to remove scales and sludges—those deposits that cut the capacity of process and steam generating systems. Dowell does the job for you and furnishes all necessary chemicals, trained personnel, pumping and control equipment.

For additional information, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

clean it chemically DOWELL

A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

DISASTER PLANNING Special Report

NO MATTER how efficient the precautionary measures, disaster may strike any refinery at any moment—without warning.

Experience has shown that it is economically and physically impossible to eliminate all the hazards posed by the three "culprits" of disaster: People, equipment and weather. Any one of these factors can destroy or seriously cripple the operations of your refinery by:

- Fire.
- Explosion.
- Wind.
- Flood.
- Sabotage.
- Direct attack.

Although elimination of all these disaster hazards is impossible, *it is possible to prepare for disaster.* Advance planning is the key. And that is the purpose of this special report—to provide disaster planning suggestions applicable to both large and small operations.

Particular emphasis is given to the eight most vital areas of disaster planning: Organization, responsibilities, procedures, training, mutual aid, communications, transportation, and public relations.

The ideas offered in each of these areas are based on material provided by E. I. du Pont de Nemours and Company, J. L. Risinger, Standard Oil Company (Indiana), Tidewater Oil Company, American Petroleum Institute, and Pan American Oil Company.

Don E. Lambert

DISASTER PLANNING

Plan for Disaster

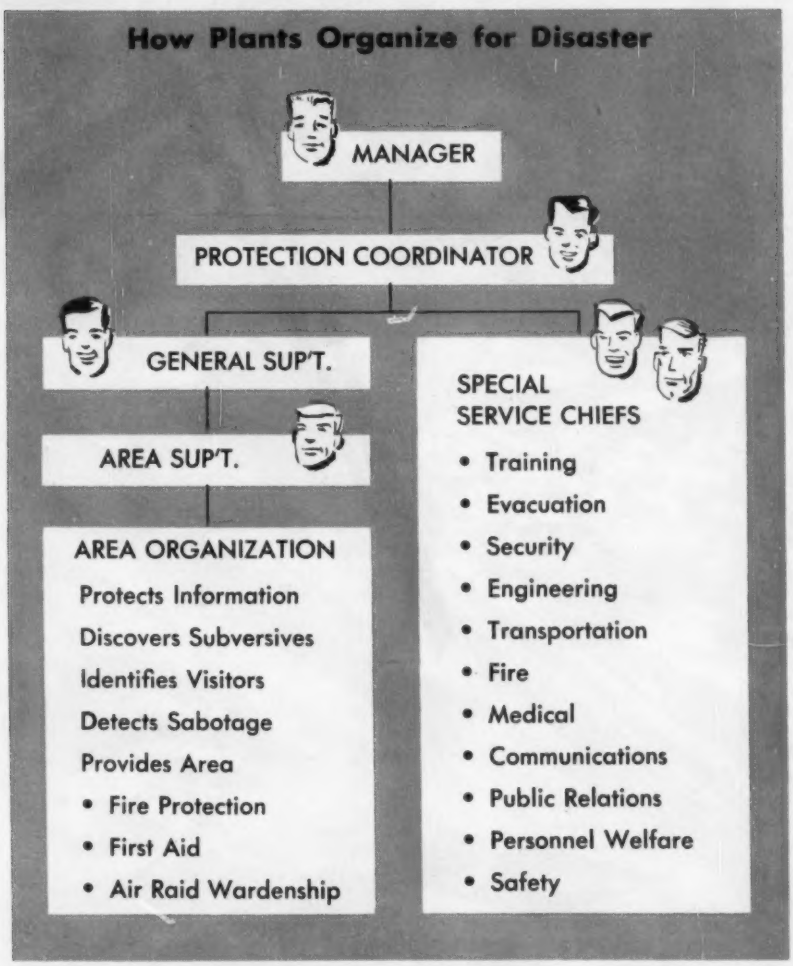
Studies of various disaster plans indicate the steps large and small refineries can take to . . .

- **Organize and establish responsibility**
- **Plan disaster procedures**

EACH REFINERY may require a different type of plant protection organization to meet its particular needs. In most instances organization planning is based on the number and kind of workers, as well as the type of fire and disaster protection facilities and equipment available at a particular plant.

Whatever your situation may be, two approaches to personnel selection are suggested:

1. Regular company employes on shift who can be spared for additional



duties with respect to fire fighting, supplemented by employees who live close to the refinery.

2. Company employes on shift, supplemented by one or more of the following:

a. Employes in the company fire department.
b. Municipal, volunteer or rural fire department.
c. Industrial-disaster or mutual aid groups.

Instead of the assignment of specific individuals within the plant, some refineries select company shift personnel for fire fighting duties on the basis of a certain number of employes from various job classifications. Thus the desired number of men are available at all times, regardless of such considerations as changes in shift, days of duty and vacations.

Opinion does not appear to be unanimous that members of the fire protection staff should be available for round-the-clock service. If the fire fighting personnel is made up of shift employes only, each member should be trained as to his duties both during normal plant operations and in the event of fire. Actually, a shift worker's job might well integrate his regular activities with his fire protection duties.

Arrangements with volunteer or with other supplemental groups should be specific so that no confusion will result as to who is charged with each phase of the fire fighting activity.

However, before such arrangements are made, the two most important aspects of disaster planning must be provided for: 1. Organization and delegation of duties. 2. Advance planning of procedures to follow at the start of an emergency.

ORGANIZATION AND RESPONSIBILITIES

In times of emergency, many refineries carry out an organization plan similar to the one outlined in Figure 1. Various aspects of this plan can be adopted by any size refinery. Following are the duties that should be assigned to each of the persons designated in the chart:

Manager and Assistant Manager. At the time of an emergency the manager and assistant manager should immediately be called to emergency headquarters where they will be available for counsel and for overall guidance of all protection activities.

Plant Protection Coordinator. Obviously, the prime consideration in setting up a refinery fire fighting organization is the designation of a qualified person to head up the group. He may be the ranking superintendent on shift, the shift foreman, or some other person in a supervisory capacity.

In some refineries the supervisor of the fire protection staff may take charge. In others he may serve as assistant to a line supervisor who is in charge of the fighting.

In a large refinery the person in charge may be called the Plant Protection Coordinator. Appointed by, and responsible directly to management, the coordinator should be a clear-thinking individual capable of making quick decisions and taking full charge in time of an emergency. The responsibility for preparing plans, establishing control centers, organizing and equipping squads and training personnel rests with him. Alternate coordinators should be appointed for all shifts.

Since the coordinator will have the over-all picture of the situation before him, he (or an alternate) should be responsible for transmitting emergency signals over the alarm system. He usually will be in the best position to determine if operating equipment should be shut down or placed in a standby condition because of emergency. The orders for instigating approved procedures in this connection should be his responsibility.

Mutual aid plans with other industrial plants in the area should be considered by the coordinator since outside assistance may be needed during an emergency. A working liaison with local Civil Defense organizations should be established to coordinate the refienry program with the community plan. This should include arrangements to receive prompt notice from the Civil Defense air raid warning system.

Reporting directly to the plant co-

Preservation of Vital Information

Should disaster strike your refinery, particularly in the case of enemy action, are you prepared to:

1. Shut down operations in an orderly manner?
2. Put the plant back in operation quickly?

Though many refineries have set up carefully laid plans for preservation of information in times of emergency, there are still several that haven't. If your refinery falls within the category of the "haven'ts," it would be well to consider the following:

Nearly always, disaster hits without warning, (with the exception of wind and floods). And there is a chance the resulting destruction will include the area where you keep information necessary for orderly and rapid shut down or start up of operations. If no provision has been made to preserve vital records, valuable time will be lost. There is even a possibility your refinery may never be able to resume normal operations.

As a precaution against this possibility, a growing number of refineries are micro-filming their process methods, engineering reports, plus names and responsibilities of key refinery personnel. This material is stored in towns or areas far removed from the potential disaster area.

"Good morale can be maintained, and the possibility of panic lessened, if employes are well informed on what to do during emergencies."

ordinator are the general superintendent, area superintendent and special service chiefs.

General Superintendents. During emergencies, every general superintendent available at the refinery should be on hand at emergency headquarters, where each will assume over-all direction of the departments or groups in his organization and the coordination of his department's activities with the protection groups. General superintendents who are off duty should be notified by area personnel and report to the plant as promptly as possible.

Area Superintendents. Each area superintendent and associated unit director should appoint an area protection coordinator, and alternate, whose responsibility includes organization of the various area groups and development of cordination with the plant-wide organization.

The area protection procedure should take into account the area functions at the time of an emergency, which in general are as follows:

1. Take steps to control operations and put everything in safe, stand-by condition.
2. Evacuate employes, assemble them at a predetermined location, and account for everyone.
3. Start fire fighting activities after notifying the fire department and carry on until relieved by the arrival of the fire department officer in charge of the fire brigade. Give technical advice to the fire department officer.
4. Initiate rescue activities needed, and see that frst aid is rendered to injured persons pending arrival of the ambulance.
5. Notify neighboring areas that may be endangered. Get word promptly to off-duty key supervision on night shifts, weekends and holidays.
6. Organize and direct clean-up work in case of building or ground contamination from hazardous chemicals handled in the area.
7. Organize area messenger service to function in case of failure of telephone service.

Facilities should be provided so that supervision in the unaffected areas will learn from the affected area, the telephone exchange, the emergency headquarters or by the fire alarm that a state of emergency exists. In nearly every instance, the plant protection coordinator or alternate coordinator is the best position to advise or supervise unaffected areas.

Area supervision assumes the duties of wardenship in case of air raids, including control of employes to prevent panic and to direct their movements.

It is the responsibility of each area to see that only persons having authorized duties enter their area and buildings. This can be accomplished effectively only if all area employes are trained to challenge anyone whose business is not known to them. In certain restricted areas, recognition will be simplified by the wearing of photographic badges on the outside of the clothing by all persons authorized to be in the area.

Particular attention should be given to working out spectator control measures in advance, and seeing that they are strictly adhered to. Specific examples can be given where oil companies have become involved in serious trouble because of lack of spectator control.

The Training Chief should assist all other members of the plant protection organization in planning, organizing, conducting and following through programs designed to prepare personnel to meet any emergency.

The individual in charge of this work should be supported by competent instructors to train personnel in the necessary functions of plant protection. In most instances these instructors would be specialized personnel already assigned to specific responsibilities in the protection organization.

The following groups should be organized, trained and hold drills at least quarterly:

1. Area or building fire brigades which can function under their own leadership until arrival of of help from the central fire department.
2. Area or building first aid squads.

Good morale can be maintained and the possibilities of panic and hysteria lessened if the employes are well informed on what to do in the time of an emergency. This may be accomplished by intelligent publicity in plant newspapers, on bulletin boards, or other similar mediums, and the inclusion of employes in the plant protection activities so that they become a part of the program.

The Evacuation Chief should be responsible for the evacuation of all persons to places of safety prior to, during, or following a disaster, and the initiation of rescue operations of disabled or entrapped persons. He should be responsible for planning and organizing the evacuation service and training of its members.

The area evacuation supervisors should be principally responsible for the evacuation of all persons to safe shelter and the rescue, or initiation of rescue operations by rescue crews, of those persons disabled or entrapped.

Provisions should be made to escort visitors to safe areas promptly.

Area evacuation supervisors should account for all personnel in their respective areas and as soon as possible submit their reports to the evacuation chief. In short, these supervisors should be the bond between the employes and the plant protection organization.

The number of area evacuation supervisors will depend upon the size of the plant and the number of areas into which the plant can best be divided. Frequent evacuation drills should be conducted so that in times of emergency all employes will know the shelter to which they are assigned

Suggested Alarm and Response Plan

(Alarms)

STATE CIVIL DEFENSE HQS.
↓
LOCAL CIVIL DEFENSE HQS.
↓
YOUR REFINERY
↓
Chief Telephone Operator
↓
Fire Officer - - - - - - - - → Sounds Fire Alarm System
↓
Power House - - - - - - - - → Sounds Power Whistle

AREA MAN PULLS BOX AUTOMATICALLY

FOR EVACUATION OF BUILDINGS
Sounded manually by Building Personnel for not less than 30 seconds.

ALERT ALARM (Industrial Only)	RED ALARM (Immediate Attack)	WHITE SIGNAL (All Clear)
Four 12-second blasts Three 10-second silences	3-Minute Continuous blast	Three 1-minute blasts Two 2-minute silences

(Response)

	AIR RAID SIGNALS			FIRE - GENERAL	
	ALERT	RED	WHITE	1 ALARM	2 ALARM
MANAGER, ASS'T. MANAGER	Check area conditions but remain dispersed	STAY PUT • ALL SEEK COVER	Check area, start rescue, fire fighting, etc.	No Action	To Emergency headquarters
PROTECTION COORDINATOR					
SPECIAL SERVICE CHIEFS					
GENERAL SUPERINTENDENTS					
AREA SUPERINTENDENTS	Put area in standby condition for attack			Own Area	Own Area
				To scene	To Field Control Center
				Other Areas	Other Areas
				No action	Stand by phone
AREA FIRE BRIGADES	No action as Brigade		Respond only on call	To box if own area	Move as directed
1st ALARM SHOP FIRE BRIGADE				To box sounded	Move as directed
FIRE DEPARTMENT (Prot. Div.)	Disperse men, equipment		To Fire Headquarters	To box sounded	Move as directed

and will go there without confusion, haste, noise, or loss of time.

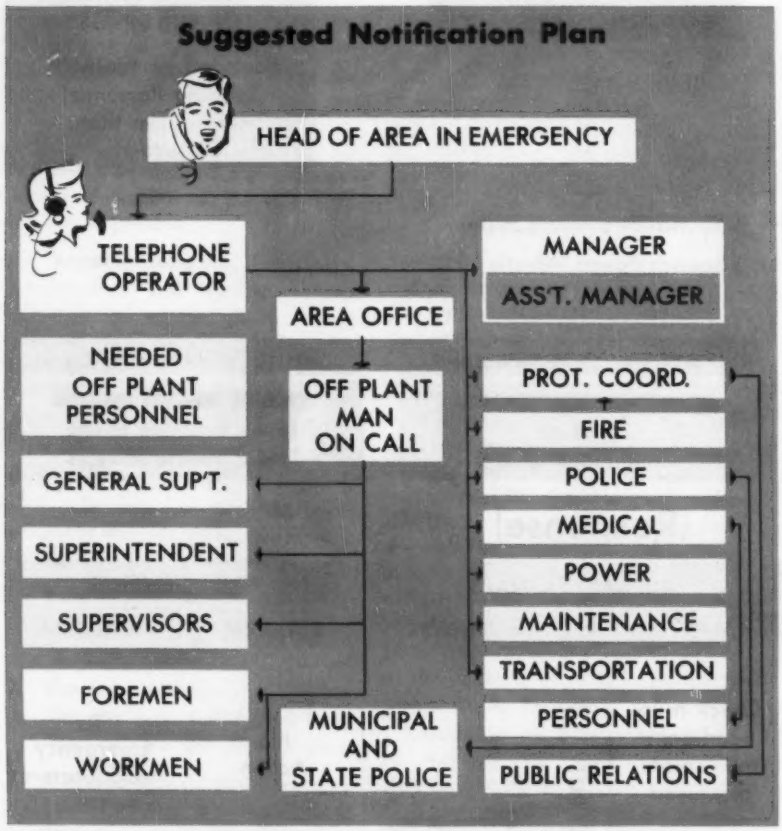
The Security Chief should be responsible for protection against espionage and sabotage, the guarding of plant property and materials, the investigation of unusual incidents, and the identification of personnel.

A liaison with local law enforcement agencies should be established in advance to work out a traffic control plan that will assure cooperation in keeping the roads to and from the plant clear at the time of a serious emergency. Methods for sending prompt notification to the police should be worked out with the communications and transpotration chief.

The security program should be no more limited or more extensive than proves warranted by a careful evaluation of the following criteria:

1. The criticality of the plant's production.
2. The vulnerability of the plant or its operating equipment.
3. The practical limitations imposed by the physical characteristics of the plan and budgetary considerations.
4. The imminence of attack.

Such evaluation should be continuing to assure that the program is consistent with the needs of adequate plant protection.



The Engineering Chief should be responsible for the maintenance of all buildings, equipment, utilities, service, etc. and the prompt repair and restoration of facilities when damaged or disrupted by a major emergency.

The position should be held by the plant engineer or someone equally skilled and thoroughly familiar with all aspects of the plant's operation and maintenance. Adequate supplies, parts, tools, etc., should be maintained to permit him to reasonably discharge his duties as access to other sources of supply may be denied. Where the interruption of operating equipment would present additional hazards, he should be given responsibility for continuation of power, including the utilization of any emergency power equipment available.

Under the jurisdiction of the engineering chief, a repair supervisor and one or more crews consisting of specialists such as electricians, carpenters, welders, riggers, pipe fitters, etc., should be organized, equipped and trained to function as a unit under adverse conditions.

Plans should be laid to isolate damaged sections of pipe lines, electric lines and other utilities or services so as to restore operations in the event of an emergency with a minimum of delay. Alternate sources of power, light, water, etc., should be considered and provided wherever practicable. Plans for the demolition of unsafe structures and the clearing away of debris should also be considered.

The Transportation Chief should be the ranking member of the refinery transport division, and should have headquarters in the plant garage.

Upon notification of an emergency he should assemble vehicles and crews at strategic points, and assign them work as requested by communications through the emergency headquarters.

The Fire Chief (preferably the officer in charge of the refinery's fire section), upon notification of an emergency, should immediately carry out the following procedure:

1. Sound the appropriate alarm.
2. Send fire truck with firemen to the scene.
3. The ranking fire officer at the scene should have other companies or equipment dispatched as may be necessary, and direct field activities until the emergency is over, or he is relieved by higher authority.
4. At the scene the fire chief should:
   a. Consult ranking member of the area or building for technical advice.
   b. Direct firemen, auxiliary firemen, rescue work and fire control.
   c. Establish the danger zone.
   d. Make sure the messenger or runner is available. The person should be selected in advance of any emergency.
   e. Request assistance or special

"The key to proper press handling during emergencies is a matter of attitude. Whoever is dealing directly with members of the press can gain their confidence by demonstrating complete frankness and candor."

services that may be required.

In the absence of the fire chief, the top ranking fire officer should take charge until his arrival.

The Police Chief (officer in charge of the police section), upon being notified that an emergency exists should immediately carry out the following procedure:

1. Dispatch the radio car to the scene of the emergency.
2. Policemen-firemen at the gates should be notified by telephone. All fence gates should be closed immediately to entry and exit, except as follows:
   a. General plant evacuation orders received by policeman from police chief to permit exit of all employes.
   b. Those holding official passes, automobile passes and those holding passes stamped "emergency" as approved or issued by plant protection supervisor.
   c. Those employes accompanied by or personally identified and authorized by holders of official, automobile or emergency passes.
   d. Outside aid summoned by plant protection supervision and approved by the plant protection coordinator. Unless specifically directed otherwise, all outside aid should be met at the gate and directed to the police chief, or his aides.

   Arrangements should be made in advance for gate personnel to receive members of the press properly.

The Medical Chief should consider the following suggestions in setting up the medical phase of a disaster control program:

1. Prepare plans for emergency use of the plant dispensary as the primary medical center.
2. Prepare plans for use of alternate and/or additional medical centers.
3. Assign doctors, nurses, technicians, first aid men, medical clerical personnel and ambulance drivers to specific jobs.
4. Inventory medical supplies and equipment.
5. Increase inventory of any supplies where warranted.
6. Prepare kit of medical supplies to be taken to, or stored at alternate or additional medical centers.
7. Prepare kit or list of medical supplies to be taken to field medical center at scene of emergency.
8. Provide emergency lighting for medical center, alternate medical centers and field medical centers.
9. Determine number of vehicles (ambulances, etc.) available to transport casualties.
10. Arrange to train an adequate number of first aid attendants (a minimum of 10 percent of plant employes is suggested).
11. Prepare procedure for accounting for injured personnel.
12. Prepare procedure for identification of fatalities and notification of the coroner.
13. Arrange with welfare director for religious rites for critically injured employes.
14. Establish hospital liaison and contact with medical supply houses for procurement of supplies (nights, Saturdays, holidays).
15. Coordinate drills with other groups in the disaster organization.

If outside medical aid is required, it should be summoned by the protection coordinator or his aides at the direction of the medical chief, or directly by the medical chief after contacting the protection coordinator.

The medical chief should also notify emergency headquarters as soon as practical concerning seriously injured persons or death cases, and keep the headquarters informed of changes in status.

The Communications Chief should handle both the regular and emergency telephone service. Since this may be put out of service by the emergency, a messenger service should be organized to function in case of telephone failure.

Short wave radio communications should be under the direction of the police chief.

Each area should provide its own plant messenger service in case of failure of telephone service, and the communications chief should recruit and have available messengers at the emergency headquarters in case of prolonged emergencies.

The Public Relations Chief should be the refinery public relations supervisor or someone appointed in his stead by the protection coordinator, manager or assistant manager.

In some cases the plant manager himself may want to assume directly the public relations responsibility. If, however, he delegates this task to another, that person should have full access to top management and be authorized to speak in the manager's name.

At most refineries the designation of an individual whose sole duty is the handling of public relations is considered essential. However, in small plants, one individual such as the communications or personnel welfare chief may perform this function in addition to his other duties.

In planning for handling public relations at a refinery disaster, it is well to bear in mind that no amount of advance planning or training can provide specific answers for the decisions which may face a public relations chief and his assistants. There are far too many possible contingencies which might arise for detailed instructions to be drawn up in advance.

The key to proper handling of press relations during an emergency is a matter of attitude. Whoever is dealing directly with representatives of the press can gain their confidence and respect by demonstrating complete frankness and candor.

By all means, arrangements should be made in advance for reception of

the press by the gate guards, plus provision of a press room adequately set up with typewriters and telephones.

Information concerning national defense contracts, including classified projects, should not be released without prior consultation with the Legal department. However, care should be taken to explain the reason for the delay to the waiting reporters.

The object of advance public relations planning is to see that reporters and photographers get accurate stories and pictures. If these suggestions are followed, you can rest assured that the general impression of your refinery will be favorable.

The Personnel Welfare Chief should be the personnel supervisor, or someone appointed by higher authority to act in his stead. Listed below are suggested duties:

1. Arrange for plant food facilities through plant cafeteria and mobile canteens.
2. Arrange in advance to meet emergency clothing needs.
3. Provide for shelter in changehouses and offices as necessary. If needed, provide for outside shelter through the Red Cross and Civil Defense.
4. Arrange all contacts with families of the injured or dead and see that notification is completed before any releases are given to the press.
5. Keep legal and compensation groups advised of any matters which might concern claims for personal injury.

The Safety Chief and Engineers should assist areas in accounting for personnel and assist the Protection Coordinator and line organization in evaluation of safety hazards and in liaison, particularly as to detection and decontamination of chemical and radiological exposures. The safety supervisors and engineers should report to emergency headquarters for assignments.

WHEN EMERGENCY STARTS

There are certain functional procedures which should be clearly understood in advance by all parties concerned to be sure that all phases of the disaster organization will be effective when required.

Individuals at the organization level may be designated who have the authority to issue instructions to sound the fire alarm for a specific zone, area, or a general alarm. Where desired this procedure should encompass notification of the group or groups furnishing mutual aid of personnel and fire fighting material. The usual air raid, fire and building alarms, plus a suggested notification plan are shown in figures 2 and 3. Advance plans should also be made for the provision of control centers.

Alarms and Notification. It is of utmost importance that each refinery have a clear, audible and distinctive emergency alarm system which is known and understood by all employes. In some refineries arrangements are made for the fire or emergency calls to be received in the laboratory, power house, main gate or other constantly attended location. (See Figures 2 and 3.)

A special telephone (painted red) is used for emergency incoming calls only so the line will not be busy as a result of use for routine calls.

A simple dial number should be selected and decals, showing the number, should be attached to all in-plant phones in the refinery. The red phone should be reserved only for emergencies. The attendant receiving the calls may be supplied with:

1. An emergency call-out list for key supervisors, local municipal fire department, ambulance service, doctor, etc.
2. In some plants a P.A. system, with speakers located in the main office, main gate, and other key locations, is used and the attendant announces the location and nature of the emergency over this system.
3. A log book for recording all calls is advisable.

There should be a call list whereby the executive group of the refinery may be notified in case of large fires or emergencies. Where desirable, the order of priority of notification for each group should be established with consideration being given to alternatives in each respective group.

At the time of an emergency, it is important that no off-the-plant calls be made except those officially authorized during the emergency, and that a minimum of in-the-plant calls be made.

In fact, employes and their families should be aducated as to the importance of not calling in to the refinery during emergencies. Arrangements with radio and television stations to make announcements would help reduce such calls.

Some refineries have plans to notify the plant protection superintendent and plant protection coordinator as insurance. If the emergency is power, the person in charge of this phase of emergency operations should notify each area. If the emergency is of another type and one that does not appear to be plant-wide, the telephone operator starts contacting areas, just in case the affected area has not notified them.

As each area is notified, if at night, weekends, or holidays, the personnel should call their off-the-plant communication to the general superintendent, superintendents, chief supervisors and needed area personnel.

Control Centers. Prior arrangements should be made to insure that emergency headquarters will be set up as soon as possible after emergency is declared. Provisions should also be made for alternate headquarters.

In the case of some localized emergency from industrial causes, it may be desirable to set up a field control center closer to the source of trouble.

The emergency headquarters should be staffed by the manager, assistant manager, protection coordinator, his aides, special service chiefs and the general superintendents. Headquarters staff members, when not at the headquarters, should keep their whereabouts known and contact the headquarters frequently.

In most instances the plant protection coordinator sees that the headquarters are adequately equipped with maps, communication facilities, auxiliary lighting and emergency equipment.

All activities of the plant protection organization should be supervised from the emergency headquarters, and all reports, requests, etc., should be channeled to this headquarters.

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TEAMWORK AGAINST TOWER FIRE—Three straight streams are directed at top of blazing tower so a curtain of water can flow down the sides until tower can be depressurized, leak eliminated and fire intensity reduced. The importance of working together is a basic lesson learned by firemen who participate in drills of this type.

Training for Disaster

Too many refineries put too little stress on advance planning and training for disaster. Following is a thorough discussion of . . .

- **What can happen if you don't plan and train.**
- **Suggested training procedures.**

BECAUSE MAJOR disasters are rare, many industrial groups have paid too little attention to their special problems. There are some situations which, if not provided for in advance, may create untold losses in property and manpower:

1. Top level supervisors, fully capable of handling difficult day-to-day operating problems, have failed suddenly when confronted with the necessity of making quick decisions during a disaster. The sight and sound of a large fire has caused even a thoroughly responsible person temporarily to lose the qualities of leadership. Panic has resulted from a lack of intelligent, cool and collected leadership.
2. If supervisors are not trained adequately in the techniques of fighting even moderate-scale fires, or if they are not familiar with the limitations of their fire fighting equipment, they may have a false sense of security when they are faced with a major emergency. They may endanger themselves, their men or cause the fire to get out of control.
3. A breakdown in communications or liaison between operations may result in overlapping or conflicting supervision.
4. The finest fighting equipment and the best trained personnel may be of no avail if leadership at the top level is faulty. This potential con-

EXTINGUISHER EXPLAINED—Delaware refinery Fire Chief Leslie C. Johns explains operation of a dry powder extinguisher to members of a Delaware volunteer fire company at Tidewater Oil Company's fire fighting school. A five hour course in oil fire fighting techniques is given to outside companies at the new $200 million refinery's fire drill grounds, 15 miles south of Wilmington.

FOAM PRACTICE—Brigade learns how to lay a blanket of foam to smother out fire in a confined area. Small pick up tube leading to foam can pick up foam solution by vacuum and mixes with water and air at the foam nozzle in the right proportion to make foam. Foam is used only in confined areas and stream must be applied gently by banking off a wall, pipe, etc., to be effective in smothering a blaze.

dition can be prevented by planning in advance for disaster and by training leadership to meet such serious situations.

At the time of disaster, if the trained supervisors know what is expected of them as a part of a coordinated plan, the psychological problems are reduced to a minimum. Following are suggested "advance" preparations for disaster:

Emergency Headquarters Drills. Obviously, every effort should be made to avoid overlapping supervision and direction, or to lose communication with the central headquarters. Advance planning and occasional out-of-door drills can establish the proper coordination between sectional commands. As an organization chart or an outline of duties on paper cannot take the place of practical training, the "headquarters emergency plan" should include drills which anticipate the most serious and complex type of emergency.

Permanent Fire Committees. Those who compose the "emergency headquarters" organization should constitute a permanent management fire committee. This committee should meet periodically to study fire prevention and fire fighting problems. It should also meet promptly after any important fire and potentially serious emergency, so that a policy for correction may be established.

If the committee's activities include training on simulated fires, the committee members will be prepared to act quickly, competently, and intelligently in the event of a major fire. They can also train their subordinates to act for them in the event of their absence from an emergency.

Unplanned Fire Drills. In some refineries the fire alarm is sounded for serious close calls. This plan has three advantages:

1. The fire fighting equipment and organization is on the spot in case the emergency gets out of hand and ignition occurs.
2. It provides an unplanned fire drill. Effectiveness of response and coordinated activities may be studied at a post-mortem meeting.
3. The fire committee members present can evaluate their plans on policies as they relate to the particular emergency.

CONTROLLING GASOLINE TANK TRUCK FIRE—Gasoline from a tank truck is spilled over and ignited to simulate an oil truck spill fire at a truck loading rack. Firemen apply fog streams to control fire until gasoline supply is shut off.

PIT FIRE PRACTICE—Three teams of firemen apply fog streams to blazing oil and gasoline in a fire drill simulating the control of a gasoline pipe line break. By working together, fire fighters can keep fire under control until flow of gasoline has been shut off. This drill is designed to demonstrate team work and the use of water in controlling and confining fire from a pipe line break.

Study Past Fires. Study of past fires is an important and often little appreciated phase of the fire training program and should be on the agenda for the committee. Fortunately no one company has a monoply on all of the lessons that can be learned from fires. Therefore, when possible, reports of

STATIONARY MONITOR NOZZLE—Instructor demonstrates the use of a stationary monitor nozzle to a fire brigade at Tidewater Oil Company's Delaware refinery. Demonstration, which took place at refinery docks, is part of intensive training in fire fighting techniques carried on continuously at the Delaware refinery. Monitor spray can be adjusted from a fine fog-like mist to a heavy straight stream and once directed at fire can be locked into position so it will continue its function unattended.

other fires should be studied in the light of "How can we handle a fire of that kind?"

Use Drill Grounds. Men trained on large fires do not become overly confident. They lose their fear of fire, but develop a wholesome respect for it. They also learn the limitations of their equipment, and in an emergency act with intelligence and good judgment, and generally conduct themselves in such a way as to avert danger to themselves.

Most of the psychological hazards which persons experience when they must face a large fire can be overcome with proper training on the drill ground. However, far too often proper drill grounds have been installed too late, i.e., after the occurrence of a major disaster, or after the improper handling of a fire has resulted in considerable loss.

Drill grounds should be built to accommodate fairly large-scale fires. They should be able to handle the large portable equipment normally employed by assigned fire crews.

Drill ground instructors may be provided by either of two plans of equal merit: All training may be done by skilled instructors from the plant fire department—or these specialists may act as teachers for the foremen or others who, in turn, may teach the men who will serve under their leadership when an emergency occurs.

Simulated fires at drill grounds should be adequate to provide proper training. Training shouldt not be limited to pit, tank and other two-dimensional fires. Adequate and realistic props can be constructed from scrap equipment at low cost. These can be used to simulate the more common jet, spray or other three-dimensional fires that may occur.

Train thoroughly. Following are three types of fire training that will adequately prepare both large and small refineries for emergencies:

1. Classroom Instruction. This "basic training" includes table top demonstrations, the fire triangle, theory regarding the burning characteristics of various fuels and the types of fire fighting mediums used.

2. Drill Ground Training. This includes four types:

a. "Primary training" in the use of one-man equipment such as hand extinguishers and small hose lines, fixed monitors or deluge sets. The drilling of operators in the handling of fixed water spray systems, monitors, etc., is in this category.

b. "Secondary training" in the handling of such equipment as large hose lines by groups. Included in this training should be a study of fire mains and foam systems.

c. "Brigade training": This invloves team work by the various groups assigned to major fires. Included is the handling of large foam equipment and towers, plus related equipment.

d. "Training of outside help": If municipal or other outside fire departments respond to plant fire alarms, it may be advantageous for their personnel, especially their officers, to be trained in the refinery.

3. Simulated Fires: "On the job" hypothetical fires should relate the drill ground work to potential emergency problems in operating areas. This can be accomplished if the refinery fire chief and an operating unit supervisor jointly plan a simulated emergency.

For example, it would be simple for any refinery to simulate a stubborn fire from a blown packing gland. When the unit is running smoothly the head operator alone is advised of the drill. The alarm is sounded alerting the crew of the hypothetical drill, and they bring up the appropriate fire fighting equipment available and start simulating emergency shut down operations. These shutdown operations may be accomplished by hanging small tags or fiber gaskets marked "open" or "closed" on valves, pumps, etc.

At the conclusion of the drill the foreman and head operator should go over the unit checking for accuracy the operators' conception of the steps to be taken in shutting down equipment under emergency conditions.

For the purposes of observation and record, one or more persons may be assigned to report on the time required to get fire extinguishing equipment into operation, and the over-all efficiency of the fire drill. The lessons learned from the drill are then discussed with the operators and the drill may be repeated to correct errors.

Such drills should be conducted periodically in all sections of the refinery. If feasible, some of these drills may be extended to include turning on spray systems, fixed monitors, the use of large hose lays, and sometimes the use of assigned fire crews.

Training Fundamentals

The Objective in Fire Protection Training is to:

1. OVERCOME FEAR: Everyone has an inborn fear of fire. But a frightened person cannot act intelligently; rather, he is likely to become panic stricken and harm himself and others.

2. DEVELOP RESPECT: Fool hardiness is unwise and may complicate firefighting. A wholesome respect for the power of fire will develop fire prevention thinking and will lead to aggressive, but safe, attack on fires that may occur.

3. DEVELOP SELF-CONFIDENCE: "Knowledge is power," a famous philosopher once said. So, with increased knowledge of fire protection comes increased confidence in one's ability to prevent fires in most cases, and to attack them effectively if necessary.

What Is Fire Protection? Fire protection as a science may be divided into three parts:

1. FIRE PREVENTION: The training that is done to prevent fires. One of the principal objectives of this training is to acquaint employes with the causes of fires so they can be prevented more readily.

2. FIRE EXTINGUISHMENT: The training that is done to insure that, if a fire is started, it will be attacked quickly, precisely, and effective.

3. FIRE CONTROL: The training that is done to minimize the spread of, or the damage from, fires. Some fires are better fought by permitting the fuel to burn out, meanwhile controlling its spread.

What Is Necessary for Fire? Three factors must be present for fire to start.

FUEL (Something to burn), OXYGEN (Usually from the air), and HEAT.

How Can Fire Be Prevented? Fire can be prevented by three separate methods:

1. Keep air from fuel and heat.
2. Keep fuel from air and heat.
3. Keep heat from fuel and air.

How Can Fire Be Extinguished? Fire can be extinguished by three separate means.

SMOTHERING: Remove the air supply. Cover vats and pans. Apply steam or water fog. Use dry compound, carbon dioxide or carbon tetrachloride extinguishers. (Foam is sometimes considered to be a smothering agent; actually, it is a starving agent.)

2. STARVING: Remove the fuel supply. To extinguish oil fires this is the best and most positive method, it is the only safe way to extinguish gas or liquefied petroleum gas (butane and propane) fires. Close valves, crimp or plug lines.

3. QUENCHING: Remove the heat. Water is best. Use fog and follow with solid streams if necessary.

How Can Fires Be Classified? Fires can be classified in three groups according to the fuels involved.

1. CLASS "A" FIRES. Those involving miscellaneous solid combustible materials such as paper, fabrics, woods, milling dusts, finely divided metal, and, in fact, any combustible materials other than those described below.

2. CLASS "B" FIRES are those involving flammable liquids and vapors. While petroleum and its products probably are the principal items of this class, paints, varnishes, lacquers, thinners, and many products of the chemical industry are of importance.

3. CLASS "C" FIRES are those in or involving electrical circuits and equipment.

Class "A" Fires: (Miscellaneous solid combustible Materials, paper, etc.)

QUENCHING is the most important method of extinguishing fires in nearly all class "A", miscellaneous combustible, materials.

Class "B" Fires: (Flammable liquids and vapors.)

1. STARVING, SMOTHERING and QUENCHING are used in fighting class "B" fires, which are divided into subclasses:

(a) B-2, Two dimensional fires, where the fire and the fuel are substantially in a single plane and on a flat surface, as in a spill, tank or trench.

(b) B-3, Three dimensional fires, where the fire is complicated by a jet or a falling stream, or free vapor as in an LP gas fire.

2. TWO-DIMENSIONAL FIRES may be fought with almost any extinguisher that has sufficient area-capacity. Water fog or chemical or mechanical foam must be used on large fires of this subclass.

3. THREE-DIMENSIONAL FIRES: Shut off the flow of fuel. This is the only safe way of extinguishing liquefied petroleum gas (butane and propane) fires, or any other fire to which the fuel is supplied under pressure.

Class "C" Fires: (Electrical circuits and equipment.)

1. KILL THE CIRCUIT if possible to prevent damage to the equipment and to reduce hazard to the fire fighter.

2. NON-CONDUCTING EXTINGUISHERS usually are best to permit immediate resumption of operations. Use carbon dioxide or dry compound extinguishers.

3. SMOTHERING AND QUENCHING are effective after the circuit has been killed. Do not use water or foam type extinguishers on live circuits.

Set Up Coordinate Activities. In the handling of major disasters, fire fighting is only one part of the job. Related emergency activities must be smoothly coordinated with the fire fighting, or other cause of destruction. Advance planning, and wherever practicable, training should be provided. Some of the most important of these include:

1. Medical procedure, including first aid.
2. In case of fire, shutting down of equipment and re-routing of fuel from the fire area.
3. Special emergency maintenance work.
4. Control of utilities.
5. Transportation and marshalling of reserve manpower and heavy fire fighting equipment.
6. Shutting off all extraneous use of water from fire mains when the fire whistle is blown.
7. Evacuation procedures.
8. Functions of plant police.
9. Communications.
10. Public relations.
11. Personnel welfare.
12. Safety.

Tidewater's Training Program

A CONTINUING PROGRAM of preparedness has been adopted by Tidewater Oil Company to protect its new $200 million Delaware Refinery from the petroleum industry's worst enemy—fire. Although the Delaware Refinery, located 15 miles south of Wilmington, is equipped with the most modern fire prevention and control facilities, the company is guided by the rule that equipment is only as good as the men who use it. So particular emphasis is placed on the thorough training of all employes in methods of fire prevention and control.

All personnel at the Delaware Refinery are potential firefighters. A two-hour indoctrination in fire rules, methods of prevention and control is given to every new employe in a program under the direction of the refinery's fire chief, Leslie C. Johns, a veteran of 17 years in fire control work with Tidewater.

Following an employe's indoctrination, his training as a refinery fire fighter continues on a periodic basis. The most important phase consists of realistic exercises on the refinery's fire drill grounds where the trainees use the various types of fire fighting equipment to combat actual oil fires under controlled conditions. Through these drills, Chief Johns points out, employes gain the confidence necessary to cope with emergencies and fight fires. Most important, he adds, trained employes will better understand refinery fire hazards, methods of prevention and the need for following established fire prevention practices.

Brigade Training Is Stressed. Specialized training is given to the fire brigades who make up the refinery's main fire fighting force. These men—15 to 18 General Service Operators and laboratory people on each of the refinery's three shifts—step into the role of firemen as crew members of mobile fire apparatus and at a moment's notice respond to all alarms under the direction of the fire department supervisor on duty. The training of the brigades never ceases, each group receiving one and one-half hours of instruction and practice every three weeks.

An auxiliary force of firemen skilled in combating oil fires has been created by a novel, mutual aid program under which Tidewater has joined forces with a number of volunteer fire companies from nearby Delaware communities. A fire fighting school is conducted at the refinery so that outside volunteers can learn the specialized techniques of fighting oil fires.

The purpose of the school is twofold. First: To create a force of skilled firemen upon whom the refinery can call for assistance if the need ever arises; and second: To give the volunteers training they may someday need in fighting oil fires in their own districts. Chief Johns organized the school at the request of a number of volunteer fire chiefs who visited the refinery and expressed an interest in learning oil fire fighting techniques.

Drawing upon the regular course of training prepared for the refinery fire brigades, Johns developed a five-hour session for each company. He scheduled the sessions on weekends so they would not interfere with the volunteers' regular jobs.

The course begins with a blackboard session in which the basic characteristics of oil fires are explained. Then comes instruction on equipment and an opportunity for the visiting volunteers to familiarize themselves with the various types of extinguishers, nozzles, chemicals and other refinery fire fighting devices. The last part of the session deals with the actual handling of apparatus at the refinery's fire drill grounds, where oil fires are set under controlled conditions and then extinguished under Chief John's direction.

Training Is Just the Beginning. The entire training program is but one facet of the refinery fire department's operations. Under its principal objective, the protection of life and property at the refinery, its other responsibilities include the drafting and enforcement of all refinery fire safety regulations, maintenance of equipment, and in an emergency directing the fire fighting crews.

To carry out the department's duties, Chief Johns has a staff of five fire inspectors and two fire guards.

At least one fire inspector is on duty at all times to assume complete charge in the event of a fire and to enforce stringent fire safety rules. For example, tools and equipment which present a source of ignition can be used only after the job has been inspected and a fire permit issued by the department. If the hazard warrants it, a fire guard will stand by while the work is done to make certain all necessary precautions are taken.

Weekly inspections of all refinery facilities are also made by the fire department to ensure the carrying out of good fire prevention practices.

Housed in its own building, the Delaware Refinery Fire Department is equipped with the most modern fire fighting apparatus, including many specialized devices for combating oil fires. But the refinery's greatest potential for avoiding a major blaze is the never-ending training program designed to teach its men how to think and act in an emergency. "After all," says Chief Johns, "the best fire fighting facilities are only as good as the men who use them."

DISASTER PLANNING

How to Set Up a Mutual Aid Plan

Here is the information you need to set up a mutual aid plan in your area. The following check-list will help you . . .

Solve pre-organizational problems, organize the plan, and contact other sources of information.

THOUGH THE CHANCES are remote, disaster may strike at any time. If and when it does, your refinery will need all the help it can get.

That is the purpose of mutual aid plans: To develop cooperative industrial and community action whereby assistance will be available to cope with an emergency which is beyond the ability of the affected member to handle.

Estimates are that less than 20 U. S. industrial areas now have mutual aid plans. Many more are needed. If you have plans to establish mutual aid in your area, the following check list and organization suggestions will be of help.

PRE-ORGANIZATION PROBLEMS

1. Ascertain which industries, in a pre-determined area, are interested in a mutual aid plan.
2. How will your union react to exchange of employes?
3. What is the legal responsibility of a company to employes while working for another company, and while traveling to and from other companies' property?
4. How will the program effect insurance coverage, such as workmen's compensation, etc.?
5. Who will supervise employes while they are off company property on mutual aid assignments?
6. Who will be responsible for damage to or destruction of equipment while assigned to another company?
7. Who will pay for supplies and materials used during mutual aid assignments?
8. Who will pay salaries and wages of employes while working for another company?
9. Who will be responsible for maintaining mutually-owned equipment?
10. How will Civil Defense, Municipal, State and service organizations fit into the plan?
11. How will equipment and personnel be transported to the scene of the disaster?
12. What training will be needed and how will it be standardized?
13. What identification system will be used to pass personnel and equipment to and from the disaster?
14. Who will be responsible for keeping records and for the exchange of information?
15. What will constitute an emergency sufficient to put the mutual aid plan into effect?
16. Will aid be limited to equipment and manpower, or will technical services be included?
17. Will it be compulsory for a member company to dispatch manpower and equipment to a scene of disaster?

HOW TO ORGANIZE

1. Executive Committee.

a. Duties:

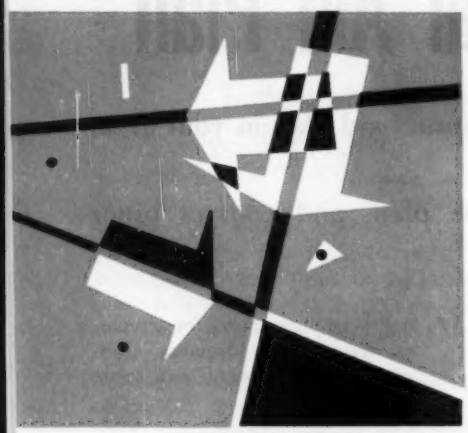
1. A representative from each member company should select this committee.
2. A chairman, with two or more alternates, should be selected.
3. The executive committee will formulate policies, establish agreements, and act in an over-all executive capacity. It will appoint the necessary subcommittees, including the following: Communications, traffic control, equipment and plant emergency, medical coordination.
4. It is important to remember that mutual aid plans are voluntary organizations, with management of each plant in command of its own facilities and personnel.

2. Communications Committee.

a. Duties:

1. Identify the communications needs that would exist in the event of a disaster

and anticipate the special problems which might arise.
2. Inventory existing communications equipment and make arrangements for its emergency use.
3. Provide secondary communications systems for use in the event the primary system becomes inoperative.
4. Arrange for communications between Civil Defense headquarters and member companies.



Traffic Control

5. Arrange for communications between each member company.
6. Arrange for communications between air raid warning networks.
7. Establish a communications control center and arrange for communications between it and each member company as well as police agencies, Red Cross, Civil Defense, ambulance services, hospitals, etc.
8. Receive and disseminate emergency information.
9. Receive reports and requests for assistance.
10. Maintain contact with affected plant and other member organizations to facilitate exchange of information.
11. Maintain an up-to-date list of communications equipment.
12. Release pre-disaster information to newspapers, radio stations, etc., and be responsible for good public relations. (Management of the disaster plant will always give out information regarding a disaster.)

b. Types of Communications:
1. Telephone.
2. Telegraph.
3. Two-way radio.
4. Commercial radio stations.
5. Ham radio operators.
6. Teletype.
7. Sound trucks.
8. Messenger service.

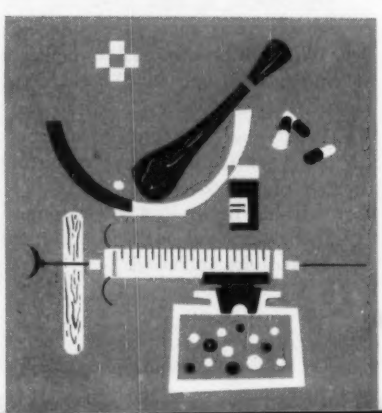
3. Traffic Control Committee.

a. Duties:
1. Establish traffic control zones in the areas of member companies.
2. Coordinate efforts of police forces.
3. Establish plans for the control of traffic in and out of member companies' properties.
4. Establish necessary road blocks.
5. Work out identification system to pass needed personnel in and out of plants during disasters.
6. Establish plans for necessary personnel and equipment to pass through road blocks.

4. Medical Coordination Committee.

a. Duties:
1. Formulate plans for medical and first aid.
2. Obtain lists of available ambulances, nurses and hospitals in the area.
3. Establish plans for emergency first aid shelters.
4. Establish procedures for identifying disaster victims.
5. Receive and surrender to rightful owner the property of disaster victims.
6. Dispatch disaster victims to first aid stations and hospitals.
7. Establish morgues.
8. Be responsible for recommending that sufficient personnel in each company is adequately trained in first aid.
9. Prepare lists of medical and first aid supplies available at each plant.
10. Establish a pool of first aid and medical supplies which can be drawn upon when needed.
11. Make plans for rescue work.

Medical Coordination



5. Equipment and Plant Emergency Committee.

a. Duties:
1. Obtain and maintain lists of personnel and equipment available for disaster use in each member plant.
2. Obtain a list of officials in each member company who are authorized to request assistance.
3. Obtain names of officials in each member company who may authorize assistance, when requested.

For additional information concerning mutual aid plans, you may contact the following:

1. Mutual Aid System, Baton Rouge, Louisiana.
2. Industrial Mutual Aid System of Texas City, Texas.
3. Houston (Texas) Ship Channel Industries Disaster Aid Plan.
4. West Hudson Council for Interplant Coordination (Harrison, N. J.).
5. Kanawha Valley Industrial Emergency Plan (West Virginia).
6. Industrial Mutual Aid Group (Worcester, Mass.).
7. Electric Utility Mutual Aid (Massachusetts).
8. Evendale (Ohio) Industrial Civil Defense Mutual Aid Organization.
9. Linden (New Jersey) Mutual Aid Group.
10. Rubbertown Mutual Aid and Traffic Control Plan, Louisville, Ky.
11. Sabine-Neches (Texas) Fire Chiefs Association.
12. Victoria (Texas) Industrial Mutual Aid Association.

DISASTER PLANNING

Communications

"Good communications is the key to effective disaster control."

SHOULD DISASTER strike and normal lines of communication be disrupted, will the disaster control organization continue to function effectively? Or will it deteriorate into many small groups of individuals working at cross purposes with each other?

Unless alternate means of communication are provided, it is possible that the latter may happen.

A disaster may severely damage or destroy the normal system of communication; and, therefore, sound, flexible plans should be developed so that in any emergency some form of communication will always be available. Separate plans will generally be required for the maintenance of off-the-plant and intra-plant lines of communication.

Intra-Plant. The use of communication systems within the plant during an emergency should be limited to specific individuals whose duties as members of the disaster control organization require it. To insure that the control center can readily contact necessary locations within the plant, several alternate methods of communication should be provided

In many emergencies, the regular intra-plant telephone system will be functioning and should be utilized to the fullest extent because of the wide coverage provided, and because employes are more familiar with it than other methods of communication.

It may be necessary to supplement the telephone system with other means of communication, or when it fails, to provide a replacement. In some of the larger plants it may be possible to justify short-wave radio systems by using them in daily operations for dispatching mobile equipment, by installing them in patrol cars, etc.

Installations may consist of central station equipment and several portable units or may be no more than two "walkie-talkies." A gasoline-driven generator can be provided as an emergency source of power for the central station equipment. Arrangements may also be made with employes who are licensed amateurs with mobile units in their automobiles for the use of their equipment.

Several other types of equipment which can be used for intra-plant communication include:

a. Sound-powered telephones—reliable, easily maintained—the cost of which can frequently be justified by their many day-to-day uses in maintenance, construction and operations.

b. Battery-powered, hand portable megaphones. Several types have suitable characteristics and are reasonably priced.

c. Public address systems. Permanently installed systems provide an excelent method of sounding alarms, informing employes of the emergency and issuing supplementary directions to them.

d. Messenger service. A group of trained messengers, either on foot or in vehicles, can be provided to supplement other methods of communication, and in the event of the failure of all other types, to provide a reliable method of communication.

Off-the-Plant. Communication with off-the-plant locations will be necessary in order to contact off-duty employes, police and fire headquarters, hospitals, other members of mutual aid groups, and relatives of injured employes.

In many emergencies, especially those involving explosions and fires, it can be expected that the plant switchboard will be engulfed by an avalanche of calls completely overwhelming the system and probably causing a complete breakdown. This is particularly true of dial systems. in anticipation of this condition, an unlisted telephone, completely independent of the plant switchboard, can be installed to provide contact with the outside.

The regular telephone lines through the private branch exchange and the unlisted line should, of course, be used as long as they are in service. However, should this system fail, there are several ways of maintaining contact with off-the-plant locations.

In some instances, it may be possible by prearrangement with any of the several police agencies to have a radio-equipped patrol car dispatched immediately to the plant on notification that an emergency exists. Arrangements can also be made with taxi companies for the assignment of a radio-equipped taxicab to the plant on request. There are also, in many plants, licensed amateur radio operators who have transmitters mounted in their automobiles.

Arrangements can be made with local radio and television stations to broadcast information bulletins periodically during a disaster which may forestall some telephone calls from the general public should the plant system fail.

Many municipal fire alarm telegraph boxes are provided with a jack for plugging in a handset to provide telephonic contact with fire headquarters. At plants where an alarm box is nearby, it may be possible to make arrangements with the local fire department to use this facility in an emergency.

In order to receive information from radio stations during widespread disasters, a portable, battery-operated AM radio can be provided.

The last resort, slower but perhaps as reliable as any, is a messenger service either on foot or provided with transportation. It is desirable in all instances to provide as many alternate means of communication as possible.

Efficient and effective control of disasters is dependent to a large degree on the rapid transmission of accurate information and directives. The methods listed here can provide that type of communication and it has been found in many plants that the equipment can be used advantageously in routine operations. However, the type, the quantity, and the number of alternate methods of communication will vary in accordance with the size of the operating plant.

DISASTER PLANNING

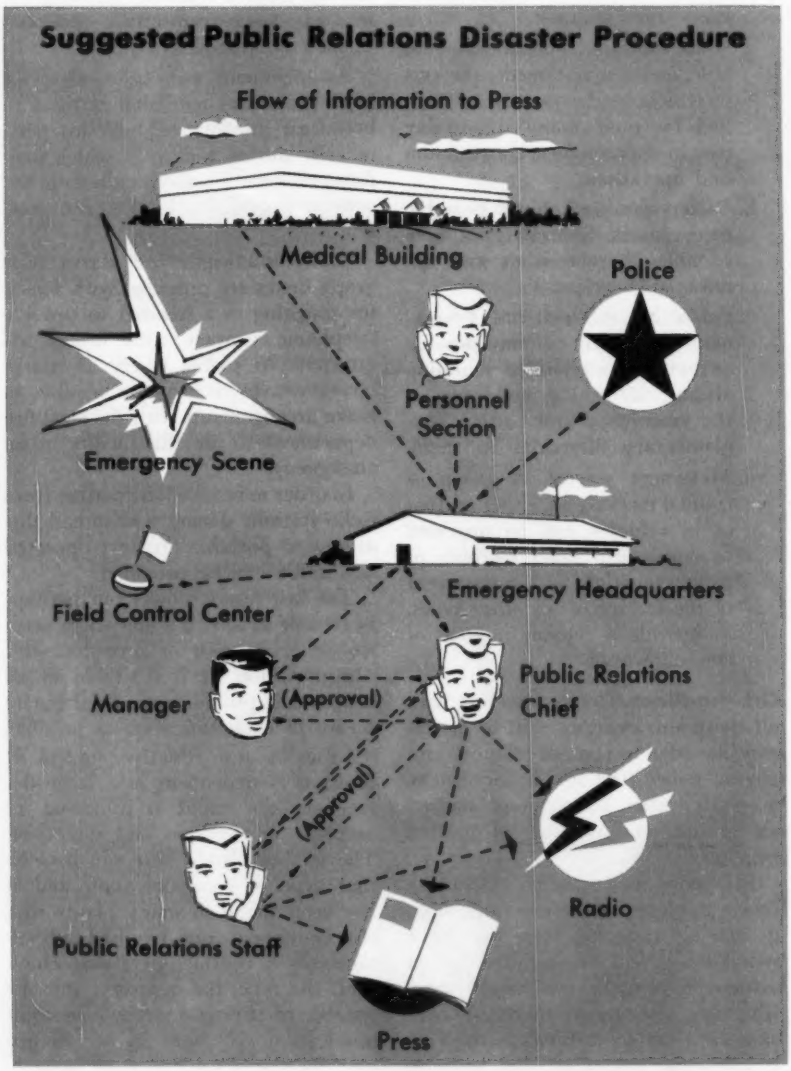
Disaster and the Public

Advance public relations planning paid off handsomely for Indiana Standard during the Whiting fire . . .

On August 27, 1955, a unit exploded in the Whiting, Ind., refinery of Standard Oil Company (Indiana). The time was 6:12 a.m. Fragments of steel killed a boy, injured his brother, and smashed into some nearby houses. Hundreds of windows were broken. In the refinery the steel fragments tore into storage tanks, spilling crude oil and products which were soon ablaze in a 10-acre area.

Flames rose hundreds of feet. Heavy black smoke ascended into the clouds. The heat ruptured fuel tanks, twisted railroad tracks, melted boxcars. An oil fire always looks worse than it is. But this one really was bad. It was to last eight days.

Occurring on one of the world's busiest highways only 17 miles away from Chicago's loop press center, the fire was bound to become known to the world in a few minutes. What kind of story would follow?



Standard Had Prepared for the Emergency. Indiana Standard's press policy was spelled out well in advance in its refinery public relations manual: "Willingly and immediately permit access to plants for bona fide reporters and photographers in times of emergency. such as fires and floods, to the limits of national security and human safety. Provide factual information to correct misstatements."

The company also had an operations plan for the reporting of an emergency and handling of the press. First formulated in 1947, it had been progressively revised.

Standard also puts out periodically a contact card for city desks, showing all phone numbers and addresses of five public relations men in Chicago. Each considers himself on 24-hour call.

Standard's Pubic Relations department dates back more than a quarter century. It has developed the philosophy that it should be a good citizen, treat people right, heed their opinions, and keep them informed—a philosophy, backed by top management.

Here's how the planning worked and how the philosophy provided the answers for questions that had never before come up:

Press Center Was Set Up. A few minutes after the blast the refinery's community relations representative was at the plant helping early-bird newsmen. Indiana Standard's public relations director was gathering details by phone and marshaling his staff.

Following the emergency plan, he asked various staff members to set up press headquarters in the refinery and to handle calls at Standard's general office in downtown Chicago.

During the morning, PR and industrial relations men drove carloads of reporters, photographers, radio and

television men into the refinery to see the fire-fighting. The PR men made on-the-spot tape recordings, and phoned reports of the fire's progress back to the press room. Personnel there put out bulletins for the press room bulletin board and kept the Chicago PR staff informed.

When the fire burned out the plant's telephone lines, the press room was hastily transferred to the administration building outside the refinery, where reporters had access to phones.

Coffee, milk and sandwiches were also supplied there for the following three days.

Communications Rolled Smoothly. To keep the pressroom informed, Standard's PR men inside the plant used a Bell Telephone mobile radio unit. Later some reporters phoned their own city desks from this unit while watching the fire. That night a two-way radio was installed at press headquarters to keep PR men and refinery officials in constant touch with fire headquarters and other points in the plant. Refinery officials made themselves available to answer questions at press headquarters, despite many other duties.

In Chicago PR staff members answered queries, spiked rumors, relayed information from the refinery and reproduced its bulletins. They also relayed to the proper personnel offers to help and inquiries of customers. They distributed to city desks a new booklet about the refinery, a previously written story about the plant's excellent fire protection setup, and a picture of the ill-fated unit before the explosion.

By late afternoon Standard told newsmen the fire had been contained, corrected erroneous reports about casualties. That evening they issued an authoritative statement on damages, noted the plant loss over $1 million was covered by insurance, and assured customers supplies were adequate for immediate needs.

Official Statement Came Early. At PR's instigation, Standard's Chairman Robert E. Wilson promptly issued a statement and made a taped interview placing moral and social obligations ahead of legal technicalities. He promised the company would act quickly to compensate families of dead and injured and to repair damage. The refinery manager publicly thanked the community for its help and announced an office would be set up immediately to handle claims.

The refinery press room and inside-the-plant spotter jobs were manned continuously around the clock for four days on a shift basis.

Chicago Sunday papers streamered the story and papers across the country played it big. But the timely statements by Standard officials, comments on the plant's safety record, its insurance coverage, haste to compensate for injuries, and sound supply position, were well in evidence.

By noon Sunday Standard put out a roundup release pegged on expected control of the fire within hours. Late that afternoon a second wrap-up announced the fire had been controlled, repeated earlier assurances, told of meetings on plans to put the refinery back in operation, and said employment would not be affected. It explained the purpose and working of the ill-fated unit The release also went to managers of Standard's sales divisions and refineries so they could speak authoritatively about the fire on Monday.

"Cooperation" Was the By-Word. Releases and bulletins continued to be delivered to city desks as well as to legmen at the plant. Trips for newsmen into the fire area continued as long as the fire lasted. Television crews were given complete cooperation. NBC's "Today" show televised live from a refinery building rooftop, with the fire as background for interviews.

When the claims office opened Monday, Standard kept the press informed on the number of claims filed and settled, and total amounts paid. That night on television, Company President Frank O. Prior thanked all concerned, expressed regret at the accident and thanks that the casualties were relatively few. He told how the company expected to bring the plant back to normal operations soon, how it would keep supplies flowing, and pointed out that only about 2 percent of the company's supplies of products had been lost. Texts were simultaneously released to the press, and the statement later appeared as an institutional ad.

The refinery pressroom was no longer needed after the fifth day, but questions continued to be answered speedily from both the refinery and general office. Follow stories were numerous. One concerned Standard's decision to buy, at fair prices, properties that had been damaged near the refinery. The last release on the fire was phoned to the press Sunday morning, September 4. It announced the flames had been quenched.

Meanwhile, refinery personnel had quietly helped the community solve problems. Standard joined Whiting's civic officials in putting emergency plans into effect, aided the Salvation Army and Red Cross in establishing and supplying canteens and relief headquarters, provided medical treatment, lent cots to individuals providing housing for evacuees.

Emergency vehicles received free gasoline and neighboring fire departments were later supplied with equipment. Four employes donated blood for the child injured in the blast, employe groups sent him presents, visited him daily. Later a tutor was arranged for him.

Families of Standard employes were notified of their safety and whereabouts by phone. One wife later wrote, "it was so pleasant to . . . receive the comfort they gave me when I was desperate in not knowing what to expect." Four days after the fire began Manager Endres sent a letter to all empoyes thanking them for their cooperation and spelling out the full-employment, regular-pay-rate policy that was to be followed.

A Chicago newspaper reporter wrote to Dr. Wison of the courtesy and service rendered to the press by the public relations department of Standard: "Within a half hour of the initial explosion until the last tank was extinguished eight days later, the members of the radio and press received the utmost in cooperation and help in obtaining both their stories and pictures."

Don Campbell, then assistant director and now director of public relations for Standard, says, "It was a classic example of the public relations precept—do the right thing and tell the world. Dr. Wilson did the right thing in his immediate and forthright action and statement, and our operating and public relations people helped reporters tell the world by providing them with fast, accurate information and guided access to the scene."

As a result of Indiana Standard's far-sighted and progressive public relations policy, the Whiting disaster was covered with accuracy and sympathy, resulting in a favorable press throughout the nation.

CHECK LIST FOR DISASTER

Assuming that a major emergency has hit your location and disaster threatens. The following problems should be considered:

ALARM	Do you have emergency warning signals which are understood by all employes on all shifts and does each employe know what is expected of him upon hearing a specific alarm?
EVACUATION	It may become necessary to evacuate certain areas where serious hazards would exist during an emergency. Does each employe know where the rallying locations are?
SHUT DOWN	Will emergency shut-down or standby procedures become necessary? Where continuity of operations is essential, is that covered in the emergency plan?
POWER	Imagine that the normal source of power is cut off. Are emergency sources available for water pumps and other emergency equipment?
FIRE	Fire is the greatest destroyer of property. If fire breaks out in more than one location, are there trained auxiliary brigades and equipment available?
CONTROL CENTER	Experience has demonstrated the need for a location selected in advance for use as an emergency headquarters. Have alternate and field sub-centers been considered? Has the chain of command been established to take charge in the event the plant co-ordinator or manager is not there?
COMMUNICATIONS	Emergency communications can be vital. What would happen if telephone facilities were knocked out at your location? Do your plans include alternate facilities?
SECURITY	Suppose your fence line was damaged or knocked down. The guard force needs help. The procedures established to handle suspected acts of sabotage?
RECORDS	Have provisions been made for safeguarding valuable and important documents?
MEDICAL	Assume that eight employes are simultaneously affected by the cause of disaster. Would that overburden your medical staff? Then assume that 15 or 20 need immediate help. Do you have enough trained and qualified first aid assistants?
RESCUE	If a number of employes were trapped in wreckage at the same time as those other things were happening, are there trained personnel prepared to handle rescue operations?
REPAIRS	Emergency repairs may be the difference between a near miss and a real catastrophe. Have repair crews been incorporated into your emergency plan?
DECONTAMINATION	If toxic gases or other contaminates are a possibility at your location, have provisions for measuring and controlling such hazards been considered?
TRANSPORTATION	Have provisions been made for emergency transportation on all shifts? What about outside transportation help?
TRAFFIC CONTROL	Keeping the roads outside the plant clear can be most important. Have arrangements been perfected with local law enforcement agencies to accomplish this?
MUTUAL AID	Has this been discussed with neighboring plants or communities. If it hasn't, perhaps you can take the lead.
PUBLIC RELATIONS	A very real problem which needs advance planning is public relations. Lack of planning in this area can prove costly.
WELFARE	Important for personnel morale. Have provisions been made for giving hot beverages, food and dry clothing to the rescue workers?

Which Polyethylene Is 'Best'?

Only when a specific product is supplied in a specific application is there a better polyethylene.

J. W. Haun
General Mills, Inc., Minneapolis

THREE OR FOUR years ago, when the great explosion in polyethylene capacity was just a tremor of anticipation, the polyethylene business looked fairly simple, at least from the outside. Today, no segment of the petrochemical industry has so successfully confused its customers, its public and itself.

Amid the rash of claims and counterclaims of "low," "high," and "intermediate" density, of "low-pressure," "high-pressure," and "conventional," polyethylenes, even well informed industry spokesmen are crying out the need for some reasonable standards in at least nomenclature.

This young product has been caught, while still in relative infancy by a huge wave of expansion resulting in overcapacity. To top even the mad promotion resulting from the overcapacity, Karl Ziegler's patents on the highly reactive organometallic catalysts, quickly followed by the Phillips and Standard Oil (Indiana) processes, have been seen as a major technological threat to the older process.

Is there really a "better" polyethylene than the "conventional" type? Let's look at some of the angles in trying to answer this question.

Characteristics of Plastics Industry. Polyethylene is, after all, a plastic, even though it is produced by operations more nearly like petroleum and petrochemical operations. The significant factor is the character of the market in which it must be sold.

• **First,** polyethylene as produced by the prime manufacturers is a raw material. Petrochemists are used to thinking of their products as raw materials, but usually as chemical individuals, sold to chemists for their chemical reactive value. Plastics are *not* chemicals, and the ordinary purchasers of plastics, the fabricators and housewives, have generally little knowledge and less interest in their chemical behavior or properties.

Any plastic finds its prime market because of its physical behavior—its toughness, clarity, flexibility or rigidity, its odor, "feel," and a hundred other properties not reducible to structural formulas. The fabricator talks to the salesman or technical serviceman about "moldability," color distribution, erratic molding cycles, poor drawdown—dozens of properties that are very real and important to him, but again not easily shown on a chart of physical properties.

• **Second,** as a result of long training by the materials suppliers, the fabricator expects service—great masses of technical manpower to work on *his* individual problems; beautifully illustrated booklets on how-to-do this or that; special formulations and color matches to specifications—all this to buyers who run the gamut from a truckload a month to millions of pounds each year.

• **Third,** the market is diffuse—at one recent time there were some 1200 injection molders to be called upon and serviced, but the situation changes swiftly so there may be many more or somewhat less today.

• **Last,** and far from least, Mrs. Housewife considers things as "plastic" or "not plastic," without knowing or caring whether she is buying polyethylene or polystyrene or ethylcellulose. Try it on her sometime—the results will show why the older successful material suppliers carry on immensely costly educational programs to try to sell plastics products of all kinds. One broken cheap polystyrene toy can set her against all things "plastic" for a long time. Furthermore, strictly functional properties hold little interest for her—in moldings it takes some "gimmick," some intriguing little "widget," to get her to buy.

All this in the final analysis means high selling cost and great consumption of technical manpower just to keep abreast of the business on production materials. Selling and research costs may consume 20 to 40 percent or more of the gross profit on a plastic material.

Characteristics of Polyethylene. Until the recent advent of nylon and polyethylene, thermoplastic polymers were considered, in actual use, simple amorphous products. They could be called "two dimensional" in that their properties could usually be defined for practical purposes in terms of only two basic molecular properties: average molecular weight and molecular weight distribution. Other molecular properties were important from a technical and theoretical standpoint, but commercially these were enough.

With the commercialization of nylon and then polyethylene, the term "crystalline polymer" came into more frequent use. It had been known for a long time that some polymers (natural cellulose, stretched rubber, etc.) tended to develop small areas with a degree of order in their structure that corresponded to a crystallization of a portion of the material.

Polyethylene therefore is a "three dimensional" polymer, since, in addi-

Which Polyethylene Is 'Best'? . . .

tion to average molecular weight and molecular weight distribution, the degree of crystallinity must be specified to define its physical behavior.

Crystallinity is a cumbersome thing to try to use for specifications and process control, and thus arises the great confusion about "branching," "linear polyethylene," "density" that defy the casual observer who tries to understand polyethylene as he does polystyrene, the acrylic plastics, and rubbers.

Since X-ray diffraction is needed to measure crystallinity itself, the industry has turned to simpler methods of measurement to try to measure the same thing. Most of these methods are concerned with determining the degree of branching of the polymer chains. To see why, it is necessary to answer the question: Why does polyethylene crystallize?

For the sake of brevity, take the reverse of this question: Why does some polyethylene *not* crystallize? The answer is: The long polymer molecules characteristic of all thermoplastic high polymers have "lumps" on them that partially interfere with the formation of crystals. These "lumps" are branches off the main chains which may be a single methyl group or a very long chain. The subject of measuring the number and size of these "lumps" is complex and certainly beyond the scope of this article, but the fact remains: They are there and they affect crystallinity—and many other properties also.

It is not surprising that highly crystalline polyethylene, because of the closer packing of its molecules, has a higher density than less crystalline polymer. Density is easy to measure in the laboratory; thus the most convenient measure of crystallinity is polymer density. Unfortunately, density alone is not really enough information and is subject to errors of surprising size. Over wide ranges, however, density can be used as a handy guide to the general properties of most polyethylenes.

For our purpose here, we can classify all polyethylenes into three arbitrary classes: "low," "high," and "intermediate." The three classes, their approximate density levels, and some alternate names are shown in Table 1.

TABLE 1

Density Class	Density Range	Alternative Names
Low	0.910-0.920	Conventional High pressure
Intermediate	0.920-0.940	
High	0.940-0.980	Ziegler type Linear Crystalline Phillips type Low pressure

The ranges of density may seem surprisingly small, but in going from "low" density to "high" density the properties change nearly as radically as the difference between rubber and nylon.

"Conventional" polyethylene is so called simply because it was the only kind for quite a few years. When the "low pressure" processes came in, it was natural that they should be so named, and since one of their outstanding properties was high density, the terms were used interchangeably. "Intermediate" density was no doubt used for lack of a better term.

Under the pressure of competition, it has been found that many so-called "high-pressure" processes can make products similar to the new "low-pressure" processes. This has only made the situation worse for one who wants to decide what product to use.

About the Author

J. W. Haun is head of the Chemical Engineering department, General Mills, Inc., Central Research in Minneapolis, Minn., where he supervises the administration of process development, pilot plant, and all chemical engineering functions including design. Dr. Haun is a graduate of The University of Texas where he received a B.S. degree in 1946, an M.S. degree in 1948 and a Ph.D. degree in 1950, all in chemical engineering. From 1948-1949 he was an instructor of chemical engineering at The University of Texas. He was research engineer for Monsanto Plastics division from 1950-1955 at Springfield, Mass., and Texas City, and Research group leader at the Texas City plant until 1956. Dr. Haun has held his present position since November of 1956.

Table 2 shows a qualitative picture of the outstanding properties of "low density" ("conventional") polyethylene with those of "high density" polyethylene. The properties of the intermediate materials are as expected—intermediate.

TABLE 2

Property	Low Density Polymer	High Density Polymer
Tensile strength	moderate	high
Yield strength	low	high
Flexibility	high	low
Processing temperatures	low	high
Color (natural)	excellent	fair
Electrical properties	excellent	excellent
Transparency	good	poor
Impact strength	very high	low

This is admittedly a crude kind of comparison for such complex materials, but it shows that both kinds of product have advantages.

Up to this point, we have not discussed the effects of molecular weight on properties. A complete discussion of the problem of measuring molecular weight in itself would take a whole article. Suffice it to say at this time that the ordinary means of specifying molecular weight is by the use of melt index. Melt index is a measure of polymer flow under rigorously standardized conditions and is related inversely to average molecular weight; the higher the melt index the lower the average molecular weight of the polymer.

Methods of fabrication ordinarily determine melt index required for a certain use. Table 3 shows a typical distribution of melt indexes and some of the end uses that material in that range might find.

TABLE 3

Melt Index	End Use
0-0.5	Electrical cable jacketing
0.5-1	Bottles, electrical insulation
1.5	Extruded film, injection molding, extrusions
3.0	Film, injection molding, extrusions
5.0	Paper coating
7.0	Injection molding - automatic-fast cycling
25	Large part injection molding
300-3000	Paraffin wax fortification, blending with high molecular weight products

Molecular weight distribution is the "third dimension" in polyethylene. A product having a substantial number of very high molecular weight molecules is tougher and more resistant to solvents and to low tem-

perature abuse. A product composed of molecules of more nearly equal molecular weight can be made which may have the same melt index as the first example but may be found brittle and more opaque.

The trouble with molecular weight distribution is that it is tedious and difficult to determine. The only foolproof method is solvent fractionation of the polymer—a procedure that may take a month and a Ph.D. to accomplish. Even then the method does not separate cleanly by molecular weights, since branched molecules have different solubilities than unbranched or less branched ones of the same molecular weight.

Only recently the material suppliers have begun to take notice of distribution in their advertising and field sales—seeking to show superior technical knowledge to their customers. The most popular measure used is the ratio of two average molecular weights, the number average determined from osmotic pressures of solutions and the weight average is measured by scattering of light by molecules in solution. For practical use, this ratio seems to be a good starting point. Values on commercial samples may range from around 3 to over 100, and should be accepted with a grain of salt until more agreement is reached within the industry on methods of measurement.

The real significance of variations in molecular weight distribution in fabrication and use has not been fully proved. Some manufacturers' literature claims that a narrow range (low value of $\overline{Mw}/\overline{Mn}$ ratio) gives highest clarity in extruded film. The present interest in this property will undoubtedly result in published work to support or disprove the claims now being made.

Other compounding ingredients are sometimes needed: antioxidants, colors, anti-block and slip agents. Some producers market 20 to 30 formulations, not counting color variations, all based on the types listed in Tables 2 and 3, but calculated to serve specialized requirements.

Is There a "Better" Polyethylene? In the final analysis, then, there are no "better" polyethylenes, just "different" ones. The addition of the dimension of density (or crystallinity) has simply added to the ability of the product to adapt itself to the end use and methods of fabrication.

Each user must therefore try to decide what *he* wants in *his* product and then select, with the help of the producers' technical men, the melt index, degree of crystallinity, and molecular weight distribution that comes nearest his requirements.

Standardization is badly needed. If the industry cannot do it, then some governmental agency will no doubt try.

Where Polyethylene Is Used . . . Now and in the Future

	Millions of Pounds	
	Now	1962
Containers		
Bottles, Jars, Tubes, Caps and Closures	30	85
Electrical Insulation	85	170
Housewares	90	135
Industrials		
Appliances, Components, Pipe and Textiles	90	180
Packaging		
Films, Coated Products	200	500
Sports and Toys	10	40
Miscellaneous	45	100
Total	550	1,200

Summary. Polyethylene, because of its tremendous growth, has serious trouble in assimilating the equally rapid changes in its technology. The industry is characterized by intensive customer service, a diffuse market, and extremely high selling costs. There is no "best" product except as that applies to a specific use under specific conditions. The industry must exert every effort to obtain some standardization of nomenclature or it will face regulation by outside forces. ##

Know Your Asphalts—Part 4

Sources and Manufacture of Asphalts

Asphalt quality is influenced by both source and method of manufacture.

E. J. Barth, Asphalt Consultant
New York City

ASPHALTS are not by-products from petroleum. They are made as distillation residues, (still bottoms), asphalt being non-distillable. However, this residue is a definite fraction of the crude. Asphalts are manufactured by careful distillation control and test procedure.

Asphalt exists in crude oil as a colloidal solution in the crude petroleum. Its source being any heavy crude that contains a sufficient quantity of asphalt to make the distillation economical. Such crudes, as Mid-Continent types and many of the Middle East varieties, also furnish asphalts distillation methods. If such crudes are reasonably paraffin free they furnish asphalts of certain grades. Paraffin base crudes do not furnish quality asphalts by vacuum distillation.

Sources. Crudes commonly used for asphalt manufacture are naphthenic or semi-naphthenic in base, of low API gravity, from 10-25 API for asphaltic types. Gravity is somewhat indicator of asphaltic content.

Quality asphalt can be made from these crudes: Mexican—Panuco, Poza Rica, Ebano; Western Venezuelan—Lagunillas, Bachaquero, Boscan, Mara, Tia Juana; California—Coalinga, Santa Maria; West Texas and some East Texas crudes; heavy Oklahoma; Kansas; Rocky Mountain "black crudes"; certain Illinois; heavy Ohio; Arkansas—Smackover; Gulf Coast—lube types; Louisiana—heavier types.

Other sources are the heavy crudes of Sumatra and Borneo; lighter gravity Middle East oil of Kuwait, Arabian, Kirkuk (Iraq) and some types of Iranian oils. Another source of asphalt by distillation is cracking coil residuals.

Manufacture. Asphalts are manufactured by the shell still or by pipe still procedure. The former is still feasible for heavy crudes with high asphalt content that are hard to crack and heat resistant, e.g., Panuco (Heavy 11.0 API Mexican crude).

However, the modern continuous pipe still is most commonly used today. The pipe still is especially good on low asphalt content crudes. The intermediate type crudes, the heavier Mid-Continent grades and most of the Middle East crudes should be processed in pipe stills.

Steam is used in pipe stills to prevent cracking. Short "residence time" and immediate flashing in the atmospheric and vacuum towers are desirable characteristics of pipe still operation. "Bottoms" in either tower should be kept to the absolute minimum. Traces of cracking that may be evident can usually be attributed to wax decomposition rather than to the asphalt molecule. These wax cracking-products, polymerized tars, go into the asphalt bottoms and often cause the Oliensis Spot Test to be positive. Certain crudes are quite sensitive at asphalt distillation temperatures and give a positive after an original negative Oliensis spot test. In practically all cases the use of ample steam is found to be most feasible.

To avoid cracking in all respects, the lowest possible processing temperatures should be used. Close temperature control must be maintained as temperatures are raised to produce low penetration and are lowered to produce soft grades of asphalt. Variables other than temperature are also important.

Crude oil, properly dehydrated and de-salted, is charged to the pipe still at definite feed rates, velocities, and at predetermined temperatures. Flashed vapors are condensed in the atmospheric and vacuum tower. Occasionally, with very heavy high asphaltic crudes, the pipe still outlet may go to an atmospheric tower dispensing with vacuum equipment. Harder (lower penetration) asphalt is produced by taking off more overhead from the atmospheric or vacuum tower. The amount of overhead distillates, penetration of bottoms, and the quality of each is entirely dependent on operating conditions and control.

Typical pipe still operating conditions on a 24 API gravity typical Mid-Continent crude are as follows:

Heater outlet	815 F	
Transfer line	800 F	
Vacuum tower bottom	660 F	
Flash section	775 F	100 mm. Hg.
Tower top	475 F	70 mm. Hg.

Heavy gas oil, wax distillate and cylinder stocks were taken overhead making asphalt bottoms of 138 penetration at 77 F.

Higher vacuum operation is not difficult and many tower construction arrangements can be used to obtain very low pressures. Properly designed flash sections are important. For example, with certain tower designs, a similar reduced crude could be run with the flash section at 35 mm. Hg. and as low as 755 F. giving an overhead off at 460 F. and asphalt bottoms at 635 F.

Preliminary pilot plant operations for each crude are necessary to furnish proper design data for large scale equipment. Asphalt can be made at lower temperatures in a pipe still than by any other method from crudes of low and high heat-resistant asphalt content.

Part 5 will appear in an early issue.

Are you up-to-date?

Recent Developments In Fluid Flow

R. C. Binder
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Why we asked for this article for our readers . . .

THE REFERENCE literature in fluid mechanics is becoming very complicated and broad. Many of our readers studied "fluid flow" a long time ago. A lot of the present day methods, even terminology, is unfamiliar to them. Certainly no other industry has a greater interest in and application of fluid mechanics than our petroleum refining, petrochemical and natural gasoline industry.

In the past few years a great variety of research and development projects has been carried out in widely scattered and specialized phases in the general area of fluid mechanics. Some of these investigations have been within, but mostly outside, our industry.

We asked Professor Binder to come to our rescue. As you well know, he is one of the foremost experts in the field of fluid mechanics. His books on the subject are accepted as the best in the field. We asked him to review the significant trends and progress in fluid mechanics. This article will be of great interest and value to the worker of our industry in indicating what others are doing and how the work of other fields might be of help to him.

At our request Professor Binder wrote this information for you in as non-technical manner as possible. No equations are given, no derivations are made, no attempt is made to show the complexity in this field. He wrote this so that our readers can get a good idea of the happenings in this important field since they left school.

We hope you like this treatment. If you do, let us know and we will cover other important subjects in the same manner.

IN ORDER to understand better current work and trends, it is well to emphasize a few principles that are becoming established. The general problem of fluid flow around a body or through a channel is divided into two parts.

In one part, we study the field or region of flow close to the surface (of the body or channel), in which there is a marked velocity change from zero at the wall (no slip) to a velocity greater than zero at some distance from the wall. This region is called the "boundary layer." Viscosity plays a major role in boundary layer flow. In the other part, we study the flow outside the boundary layer, in a region where we regard the fluid as having no viscosity or internal friction. In many studies attention may be focused only on the boundary layer. In other studies attention may be concentrated on frictionless flow alone. In the general over-all fluid flow problem, however, both regions must be considered jointly.

There are certain characteristic physical features of the flow of a viscous fluid. These are laminar flow, turbulent flow, transition between laminar and turbulent flow, formation of boundary layers, and separation. In laminar flow the fluid flows in layers or lamina; there is only an exchange of molecules from one adjacent layer to another. In turbulent flow there is superposed a fluid mass or molar movement plus molecular movement upon the main steady flow. In the transition or buffer region there is a change from laminar to turbulent flow. In so-called "separation" the fluid breaks away from the surface; there may be an eddying wake. Various combinations of these characteristics may be found in actual flows. The flow field may be completely laminar. A laminar boundary layer may separate from a body. The flow around a body may be lami-

nar in one region and turbulent in another region. A turbulent boundary layer may separate from a body.

Analogy Between Fluid Friction, Heat Transfer, And Mass Transfer. At the beginning of this century the subject of boundary layer flow was primarily of academic interest only. Fluid flow studies were directed mainly to certain problems of friction and energy degradation. Now, however, a study of boundary layer flow has become more important, or more general, practical, and direct interest. As an example, years ago convective heat transfer relations were organized primarily on an empirical basis, with the help of dimensionless ratios. Now the role of the boundary layer flow in convective heat transfer is receiving much real attention.

"The computation of the turbulent boundary layer for engineering applications is still in a somewhat empirical state at the present time, even though much theoretical and experimental work has been done on the problem."

Fluid Momentum: Momentum is defined as the product of mass times velocity. As fluid flows in a boundary layer there is a momentum transfer between adjacent layers; with this momentum transfer is associated a shear stress or friction. One of the most significant recent developments is the increasing use of the analogy between fluid momentum transfer, heat transfer, and mass transfer. There are various pieces of plant equipment and machines which involve some combination of the three transport processes involving fluid momentum, heat, and mass.

Heat Transfer: As an illustration, imagine the case of fluid flow through a heat exchanger. Close to a surface there is a laminar boundary layer. At some distance perpendicular to the surface there may be a turbulent boundary layer. Between the laminar and turbulent layers there is a transition or buffer zone. At each point in the boundary layer the change in velocity with respect to the perpendicular distance from the surface is called the velocity gradient. For each point in the fluid there is a functional relation between shear stress, fluid viscosity, other factors, and the velocity gradient. In the fluid there may be a temperature variation with respect to the distance from the surface, or a temperature gradient at each point. Thus, we can say that there is a thermal boundary layer near the surface, in which there is a marked temperature variation. The heat transfer through the thermal boundary layer is proportional to the temperature gradient.

Mass Transfer: In some cases the fluid can be regarded as a single substance with single values of such physical properties as pressure, temperature, and density. In other cases, however, there may be two or more components. Consider the case of flow of a fluid with two components (as air and water vapor). The concentration of one component (as water vapor) may vary in a distance perpendicular to the surface. There is a concentration variation or distribution. At each point in the fluid there is a concentration gradient, or change in concentration with respect to distance. The mass transfer or diffusion is proportional to the concentration gradient.

Thus, intuitively we can draw an analogy or similarity between the fluid boundary layer, the thermal boundary layer, and the layer in which there is a concentration variation. The basic relation for each transport process is similar in form. Thus the processes are said to be analogous. The fluid shear stress is analogous to heat transfer; shear stress is also analogous to mass transfer. The fluid velocity gradient is analogous to the temperature gradient; the velocity gradient is also analogous to the concentration gradient. For certain special cases the coefficients in the basic equations are identical. Thus, in some cases, if we know the results of experimental work on fluid flow, as shear stress, the results can be used to solve the corresponding heat transfer problem, and the corresponding mass transfer problem.

In the laminar boundary layer, the molecular momentum transport process results in a viscous shearing process, a heat conduction process, and a molecular diffusion process (if two or more components are present with a variable concentration distribution). In a turbulent boundary layer the mass or molar movement results in a turbulent shearing, a convective heat transfer, and a turbulent diffusion process.

Boundary Layer Flow. Increasing concern with applications involving laminar and turbulent flow and serious attempts to make engineering studies more rational (rather than empirical), has focused attention on the mechanism or nature of laminar flow, turbulent flow, and the transition between laminar and turbulent flow.

Laminar Flow. Generally speaking, laminar flow can be analyzed mathematically, and many problems have been solved directly in a rational manner. Examples are laminar flow in lubricated bearings, flow in pipes, and flow in concentric tubes. In these and other cases the experimental data agree closely with theoretical predictions. Various cases of laminar flow have been worked out for bodies and channels of relatively simple shapes, as circular and flat plates. For many problems in fluid friction and heat transfer, it is desirable to be able to calculate the laminar boundary layer for flow around bodies which do not have very simple shapes, as struts and other bodies with sections similar to that of airfoil shapes. A large number of techniques have been proposed by different investigators for calculating the laminar boundary layer and the point of separation. A critical study

of the many different techniques has established several as being relatively quick and accurate.

Turbulent Flow. A great deal of theoretical work and experimental work has been done on turbulent flow; which is very common in practice. A better understanding and a more rational analysis of turbulence would be very helpful in a wide variety of industrial applications. At the present time, however, the exact nature and mechanism of turbulent flow has not been completely established.

In laminar flow the shear stress is proportional to the velocity gradient and the dynamic viscosity of the fluid. For turbulent flow, the dynamic viscosity can be increased by a term which is frequently called eddy viscosity. Although the use of eddy viscosity is somewhat empirical, it seems to be in frequent use, and it is convenient in such cases as those involving the analogy between fluid friction and heat transfer.

"Increasing concern with applications involving laminar and turbulent flow, and serious attempts to make engineering studies more rational (rather than empirical) has focused attention on the mechanism or nature of laminar flow, turbulent flow, and transitional flow."

Mixing Length. In an attempt to provide a more rational approach to turbulence, much use has been made of several basic concepts. For molecular motion there is defined a term "mean free path" of the molecule, which means the average distance a molecule travels between collisions. For turbulent motion, L. Prandtl is credited with introducing the concept of "mixing length," which is analogous to mean free path. The concept states that in the turbulent exchange the fluid masses displaced perpendicular to the mean flow carry momentum over a certain length perpendicular to the mean flow. The mixing length is defined as the average distance perpendicular to the mean flow covered by the mixing particle. The turbulent shear stress varies as the square of the mixing length. T. von Kármán developed the general concept that the mixing length depends on some universal numerical constant, the velocity gradient, and the first derivative of the velocity gradient. These basic concepts have been applied to various problems, as the flow in circular pipes and rectangular channels. The resulting logarithmic velocity distribution for turbulent flow provides a useful starting point in many applications. Various generalized or universal velocity distributions have been proposed, to cover all layers, laminar, transition, and fully turbulent. Progress has been made in developing a statistical theory of turbulence. This theory has been useful in guiding experimental work.

Techniques have been established for computing the laminar boundary layer growth and the separation of the laminar boundary layer for bodies of arbitrary shape. The turbulent boundary layer growth and point of separation is a much more difficult problem. Although much theoretical and experimental work has been done on this problem, the computation of the turbulent boundary layer for engineering applications is still in a somewhat empirical state at the present time.

Much attention has been given to the basic problem of the stability of laminar flow and the transition from laminar to turbulent flow. It would be helpful to know the limiting ranges for laminar flow, and the conditions under which laminar flow changes to turbulent flow. This problem has been solved experimentally in various simple cases, as the flow in circular pipes. It would be desirable to have solutions and experimental data for more complicated cases. Real progress has been made in setting up a theoretical framework for calculating the stability of laminar flow. This framework looks very promising; some experimental verifications have been established. The presently available analysis is very complicated and difficult to apply. It does not appear possible to describe by a single mechanism all the phenomena associated with transition.

Frictionless Flow. The general problem of flow around a body or through a channel is broken up into two regions: the boundary layer and the region outside of the boundary layer in which the fluid is regarded as frictionless or having zero viscosity. A great deal of mathematical work has been done on steady frictionless flow, particularly two-dimensional flow. In this type the flow is identical in parallel planes. A good deal of material is available in the reference literature.

Sometimes the flow under consideration involves a rather complicated shape, the solution has not been established in the literature, and experimental work on a prototype is not feasible. Various analogies have been developed which are useful. As an illustration, consider the two-dimensional steady flow of an incompressible fluid. The basic equation for this flow (so-called Laplace equation) has the same form as the basic relation for electrical conduction and the basic equation for heat conduction. An analogy for two-dimensional flow can be set up by an electrical system. Lines of constant electrical potential can be regarded as analogous to streamlines in the fluid case and lines of constant temperature in the heat conduction case. Thus, an electrical system can be used to solve a fluid flow problem and a heat conduction problem. In a similar fashion, various numerical techniques, as the relaxation method used in heat conduction, can be used for fluid flow and some electrical problems.

Cavitation. As a liquid flows through a machine or a passage, a vapor or gas phase may co-exist with the liquid phase. In some cases the fluid pressure may hover above and below the vapor pressure of the liquid, and there is an alternate formation and collapse of bubbles. Very high surge pressures may be developed. These high pressures may blast the metal walls. This process of the alternate formation and collapse of voids or cavities is frequently called cavitation. Cavitation may result in various undesirable effects; as a marked drop in efficiency

of energy conversion, a pitting or erosion of metal parts, and a noise which may be annoying to people.

In pumping liquids, cavitation is frequently a major question, particularly at the pump inlet region. Much attention has been given to this problem of pump cavitation. The inlet flow in a pump, as a centrifugal or axial-flow pump, is very complicated. In many cases it is very difficult to make a complete theoretical analysis which will predict accurately the possibility of cavitation. General experience indicates the wisdom of previous experimental study of cavitation characteristics of a machine before the machine is placed in a permanent plant installation.

Many theoretical and experimental studies have been made to determine the mechanics of cavitation. It is generally established that the inception of cavitation in ordinary liquids is associated with the growth of nuclei, frequently submicropic in size, containing vapor and/or undissolved gas, which are present in the liquid or in the pockets of the bounding walls. Completely dissolved gases probably cannot play a dominant role in inception. In some cases the dissolved gases may exert some importance during the inception process. One significant recent development is the recognition of the importance of boundary layer and turbulence in several phases of the cavitation process. There is some evidence to indicate that cavitation can damage solids by purely mechanical processes under conditions in which chemical action is not possible. There are various cases in which cavitation seemed to simulate corrosion. The combined effect of cavitation plus corrosion may produce damage under which either one acting alone does not.

Fluid Power and Control Devices. There has been an increasing use of fluid devices in industrial power and control systems. In a hydraulic device or system the fluid is an oil. In a pneumatic device or system the fluid is compressed air. As a familiar illustration, automobile brakes are hydraulic, and the usual automobile transmission is some form of hydraulic device with a fluid coupling, a fluid torque converter, and/or a hydraulic control system.

A great variety of circuits or systems could be designed. There are, however, essentially three main parts in the usual basic system: an oil pump or air compressor; a cylinder having an actuating piston driven by the fluid; and piping with valves to control the flow of fluid. Fluid systems are used to operate valves in many refineries and process plants.

Noise. Steady flow is defined as flow in which the velocity, pressure, density, and other such characteristics at a point do not change with time. In unsteady flow the fluid characteristics at a point do change with time. There are numerous applications which involve steady flow, and much attention is given to this type of flow. Recently more attention has been given to various unsteady flow problems. Probably the most significant and easily understood trend is that concerned with noise, which can be defined as unwanted sound.

Various materials, devices, and techniques are becoming established for noise control. As a general method of attack, the objective in a noise control or reduction program is to break the chain of transmission from the sound source to the human ear. If the sound source cannot be eliminated, then the sound transmission might be blocked by sound absorption, isolation of the sound maker, or by a muffler. Various flow processes are possible sources of noises. Examples are cavitation, high velocity jets, turbulence, sudden changes in flow (as the water hammer action), and eddying flow behind a body. Various mechanical elements may cause a periodic motion. Examples are rotating runners (fan, pump, compressor, turbine), reciprocating pistons, and valve systems. A problem of noise reduction or control may involve considerable ingenuity and detective work.

"Real progress has been made in setting up a theoretical framework for calculating the stability of laminar flow."

High Speed Flow. Each fluid at a given temperature and pressure has a certain acoustic velocity or velocity of sound. For air at 59 degrees Fahrenheit and 14.7 psia this acoustic or sonic velocity is 1120 feet per second. An infinitesimal pressure disturbance or wave will travel through air with a velocity of 1120 feet per second. The term Mach number is used frequently in the current reference literature on compressible flow. Mach number is defined simply as the ratio of fluid velocity divided by the sonic velocity. This dimensionless ratio is useful in correlating data and in classifying the type of flow. In subsonic flow the Mach number is less than unity; in supersonic flow the Mach number is greater than unity. Hypersonic flow is high supersonic flow.

Probably the most publicized area of activity in fluid mechanics is that concerned with jet propulsion, missiles, rockets, high speed aircraft, and the large supersonic tunnels. Various military, naval, and government groups are doing considerable research in this field of high speed flow. Large supersonic tunnels have been built for testing models of bombs, models of aircraft, and for the testing of full size jet engines (as the huge tunnel at Tullahoma, Tennessee, which has a compressor drive of 216,000 horsepower).

Some of this current research may not be of much direct interest or

About the Author

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value to the worker in petroleum refining. Some of the current research may help, however, in clearing up details of the mechanism of high speed gas flow which might be found in various pieces of plant equipment such as, for example, in various compressors. Some of this research may have direct value in certain areas, as combustion and spray technology.

Combustion. There are some who feel that combustion is still a "little understood" phenomenon. Most of the real gaps here appear to involve combinations of fluid mechanics, heat transfer, and chemical kinetics. It appears that each new type of significantly different size of combustor must be developed by a long series of tests before satisfactory performance is obtained. It seems that the exact chemical processes that occur during the ignition and burning of commercially available important fuels is unknown. However, at the present time a good deal of fundamental work is being carried on in various laboratories around the world, and it is hoped that this activity will bear fruit in the near future.

Atomization. The process of atomization has received a great deal of attention in connection with jet propulsion. The phenomena of droplet formation, spray penetration, and secondary atomization can be characterized by one dimensionless ratio (Weber number) with secondary viscosity effects being characterized by another dimensionless ratio (Reynolds number). The ballistics of an evaporating droplet is dependent upon the ratio of air viscosity to the product of liquid density and evaporation rate, with the variation of evaporation rate due to the relative velocity effects being characterized by two dimensionless ratios (Schmidt number and Reynolds number). It appears that research is needed in certain areas, as atomization by jet impingement, coalescence of droplets, and the determination of size distribution from physical properties of the liquid, injector, and surrounding atmosphere.

Application of Shock Tube. A good deal of experimental work has been done on the so-called "shock tube" in order to develop a convenient facility for studying high velocity gas flow. The conventional shock tube consists of a duct (filled with air or gas) separated by a diaphragm into low and high pressure regions. After the diaphragm is ruptured, a plane shock is developed which moves into the low pressure region and accelerates the gas and raises its temperature. Across the shock wave there is a sharp change in pressure. Various modifications of the conventional shock tube have been devised. During the past ten years the shock tube has developed into a powerful tool for the study of high-temperature phenomena in gases. The experimental technique has made good progress. It looks as if the shock tube will be a valuable aid in studying high temperature chemical kinetics, high temperature gas physics, and hypersonic flight.

Rarefied Gas Dynamics. In fluid mechanics it is common to regard fluids as continuous media. In many cases such as at high vacuums, the mean free path of the molecule is small in comparison with the distances involved, and the flow phenomena can be studied by reference to bulk properties without a detailed consideration of the behavior of the molecules. In a study which might be classed as rarefied gas dynamics, however, the flows are at such low density that the molecular mean free path is not negligible. Interest in rarefied gas dynamics has been provoked by various applications to very high-altitude, high-speed flight. It is convenient to divide the field of rarefied gas dynamics into three different flow regimes: free molecular flow; slip flow; and the transition between molecular flow and slip flow.

"It does not appear possible to describe by a single mechanism all the phenomena associated with transitions."

Free molecular flow refers to an extremely rarefied condition in which the free mean path is greater than ten times some length characteristic of the flow field (as the diameter of a duct or a length of a high-altitude rocket). This condition generally corresponds to flight above an altitude of 100 miles. In this type of flow, molecules which impinge on a surface and are then remitted, travel far away from the surface before colliding with another molecule.

The incident flow is not disturbed by the body or structure itself. One of the most stricking results of theoretical work on free molecular flow is the prediction that the equilibrium temperature of any convex body is higher than the adiabatic stagnation temperature of the gas flow.

Slip flow refers to the slightly rarefied gas flow, in which the molecular mean free path is betwen 0.01 and 0.1 of the characteristic length dimension of the flow field (as the thickness of the boundary layer). This condition generally corresponds to flight at altitudes of 20-50 miles. Noncontinuum effects are just beginning to take place, and can be regarded in terms of corrections to continuum relations. In continuum fluid mechanics we assume that the tangential velocity along a solid surface is zero, that is, there is no slip. In slip-flow the gas is at such a low pressure that there can be a tangential velocity different from zero along a solid surface. At low speed flows there are certain non-continuum phenomena which reduce the skin friction and heat transfer.

The development of supersonic tunnels, molecular beams, and other research facilities for exploring the field of rarefied gas dynamics is presenting a host of new problems.

The solutions to these problems will also provide answers for seemingly unrelated problems in the petroleum industry.

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Time Saver!

Use Graphs to Simplify Footing Design

Here's an easy method for determining the economical sizes of octagonal and square footings used in your plant.

John B. Grant

Raymond J. Smith

Macco Corporation

Paramount, Calif.

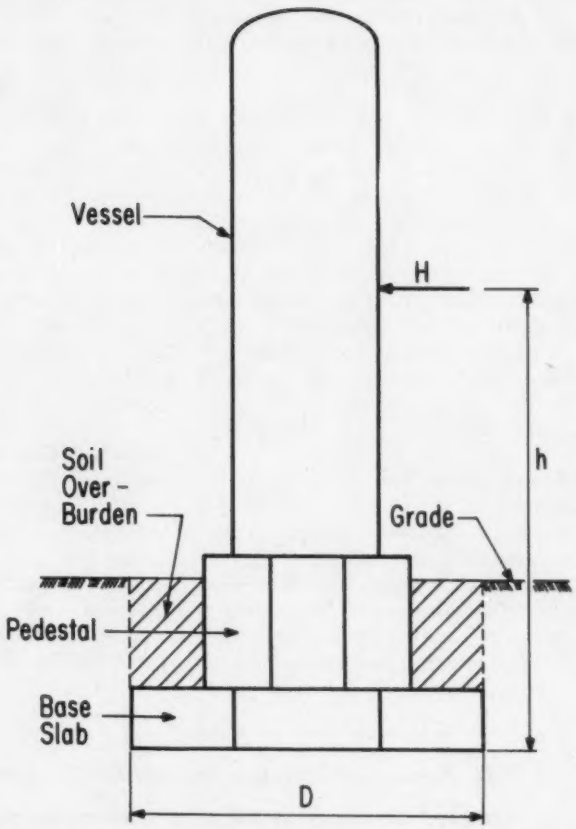

FIGURE 1—(Example) Typical vessel supported by an octagonal foundation.

OCTAGONAL and square footings constitute a large proportion of the foundations encountered in refinery and chemical plant design. Octagonal footings are widely used to support vertical vessels, stacks and similar equipment or structures. Square footings have a great variety of uses. Structural designers normally rely on a trial and error procedure of determining a satisfactory size for these foundations. Trial and error procedures are, by their nature, time consuming and therefore expensive. The charts presented in Figures 2 and 4 offer an exact and rapid graphical method of determining economical sizes for octagonal and square footings. Although these charts were initially developed as a design aid, they have proven to be quite useful for estimating and checking purposes. They have been used by Macco Corporation's structural

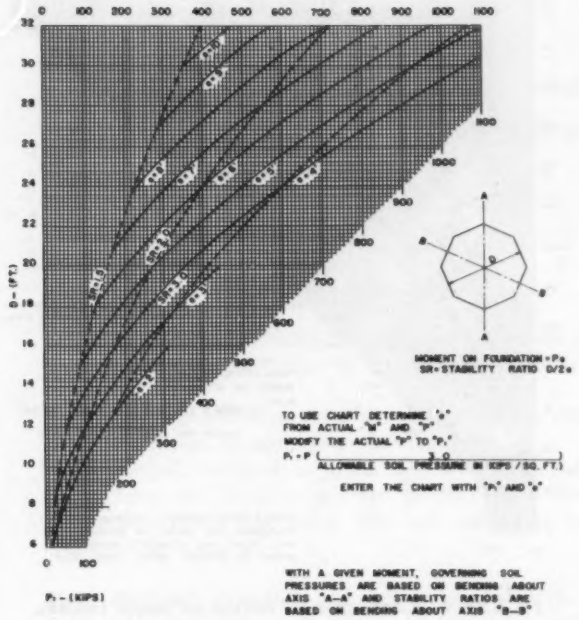
D - (FT.)
P₁ - (KIPS)
MOMENT ON FOUNDATION = Pe
SR = STABILITY RATIO D/2e
TO USE CHART DETERMINE "e"
FROM ACTUAL "M" AND "P"
MODIFY THE ACTUAL "P" TO "P₁"
ENTER THE CHART WITH "P₁" AND "e"
WITH A GIVEN MOMENT, GOVERNING SOIL PRESSURES ARE BASED ON BENDING ABOUT AXIS "A–A" AND STABILITY RATIOS ARE BASED ON BENDING ABOUT AXIS "B–B"

FIGURE 2—Exact graphical method for octagonal footings.

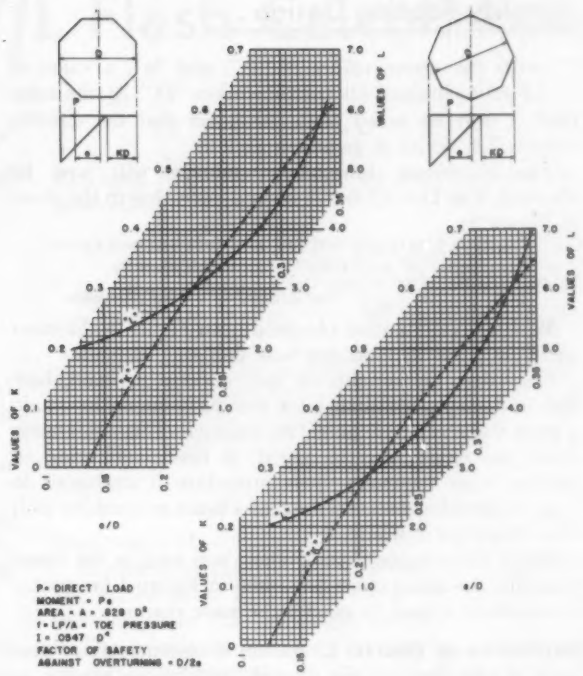
VALUES OF K
VALUES OF L
e/D
P = DIRECT LOAD
MOMENT = Pe
AREA = A = .828 D²
f = LP/A = TOE PRESSURE
I = .0547 D⁴
FACTOR OF SAFETY AGAINST OVERTURNING = D/2e

FIGURE 3—Vertical load eccentricity is measured from centroidal axis.

design group for over two years and found to be accurate as well as time saving.

Example. The use of the sizing charts may best be illustrated by an example. Assume a vertical vessel as shown in Figure 1 and the following design criteria:

For illustration purposes, the example has been limited to the operating condition plus wind or seismic. In actual practice, however, the other design conditions such as the empty condition plus wind or seismic and the test condition with or without wind or seismic must be investigated. Furthermore, the overturning moment (H x h) has been assumed as resulting from either wind, seismic, or other forces.

Design Criteria

Operating Weight	$= 120^k$
Horizontal Force "H"	$= 10^k$
Distance "h"	= 53.5 ft.
Allowable gross soil bearing pressure	= 4.0 ksf
Minimum allowable stability ratio against overturning	= 1.5

In order to use the charts, first determine the gross load "P" and the moment "H x h" at the base of the footing.

Gross Load

Vessel Weight	$= 120^k$
Concrete Pedestal	$= 28$
Concrete Base Slab	$= 49$
Soil Overburden	$= 35$
Gross "P"	232^k

Moment

$M = 10^k \times 53.5$ ft. $= 535$ ft.^{k}

From "M" & "P" the eccentricity may be found:

$$e = \frac{M}{P} = \frac{535 \text{ ft.}^k}{232^k} = 2.30 \text{ ft.}$$

Since the sizing charts were prepared on the basis of an allowable soil bearing value of 3 ksf, the gross load "P" must be adjusted to "P_1", before entering the chart.

$$P_1 = 232^k \times \frac{3 \text{ ksf}}{4 \text{ ksf}} = 174^k$$

Entering the octagonal foundation sizing chart (Figure

About the Authors

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Simplify Footing Design .

2) with the above values of "P_1" and "e", a value of 13.2 feet is obtained for the dimension "D." At the same time it may be noted from the chart that the stability ratio is 2.9, which is greater than 1.5.

The maximum foundation pressure will now be checked. Use D = 13 feet 3 inches. Referring to the chart of Figure 3:

$$e/d = 2.30/13.25 = 0.174, K = 0.182, L = 2.44$$

Area "A" $= 0.828\ (13.25)^2 = 145.4$ sq. ft.

$$f = \frac{LP}{A} = \frac{2.44 \times 232}{145.4} = 3.89 \text{ ksf} < 4.0 \text{ ksf allowable}$$

With the information obtained from Figure 3, the complete design of the concrete base slab may be made.

Note that the weights of the concrete pedestal, base slab and soil overburden must first be assumed to obtain a gross value of P. If the values assumed differ too greatly from the chart sizes indicated, a new assumption of weights must be made. This procedure is analagous to that of assuming the dead load of a beam to combine with other loads for its design.

While the octagonal sizing chart was used in the above example, the sizing chart presented in Figure 4 for square foundations is used in exactly the same manner.

Derivation of Charts. Literature in common usage presents charts for various shaped foundations similar to those shown in Figures 3 and 5 where $L = \frac{FA}{P}$. These charts are derived from the basic formula for maximum soil pressure, $f = \frac{P}{A} + \frac{Mc}{I}$.

However, since the economical or useful portions of these charts lies between the limits where tension would exist on the heel of the pad up to the point where the stability ratio against overturning is one and one-half, the basic formula is not correct without re-definition of certain of its terms:

A = The area of the pad actually under compression.
M = The moment of the vertical forces about the centroidal axis of the area under compression.
$\frac{I}{C}$ = The section modulus of the actual area under compression about its centroidal axis.

For this compressive area it is of interest to note that the average unit compressive stress occurs at the center of gravity of the compression area.

Definitions of the terms in the formula $L = \frac{FA}{P}$ and the terms needed for the graphic solution for "L" are:

F = Maximum soil pressure in kips per square foot.
P = Total vertical load on soil in kips.
A = Total area of foundation pad in square feet.
D = Distance in feet as shown in figures 3 and 5.
e = Eccentricty of vertical load in feet $= \frac{M}{P}$
L = A constant for any given value of $\frac{e}{D}$

Note that in the case of Figures 3 and 5, the eccentricity of the vertical load is measured from the centroidal axis of the total area of the foundation pad. By assuming values for "D", "F" and "e", values of "L" and "P" may be obtained to plot the data for figures 2 and 4.

Extending and Other Charts. These particular sizing charts have been prepared for footings loaded by vertical load and a moment of the same magnitude about any axis. They may be extended as desired by following the procedure outlined above.

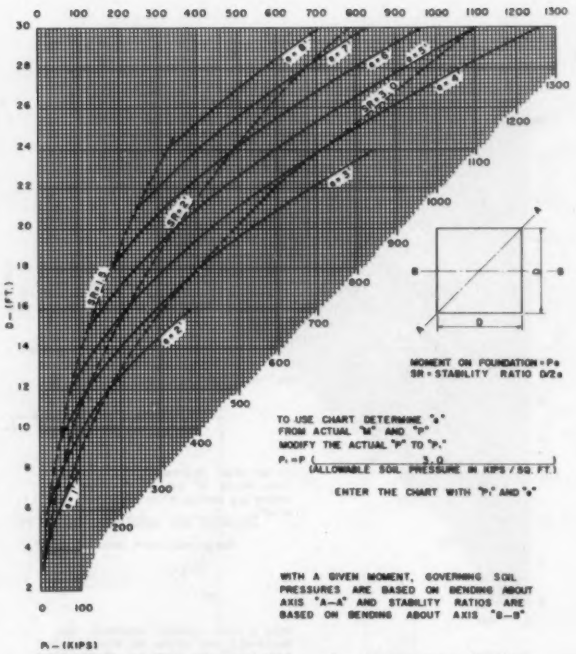
MOMENT ON FOUNDATION = Pe
SR = STABILITY RATIO D/2e
TO USE CHART DETERMINE "e"
FROM ACTUAL "M" AND "P"
MODIFY THE ACTUAL "P" TO "P1"
ENTER THE CHART WITH "P1" AND "e"
WITH A GIVEN MOMENT, GOVERNING SOIL PRESSURES ARE BASED ON BENDING ABOUT AXIS "A—A" AND STABILITY RATIOS ARE BASED ON BENDING ABOUT AXIS "B—B"
D — (FT.)
P1 — (KIPS)

FIGURE 4—Exact graphical method for square footings.

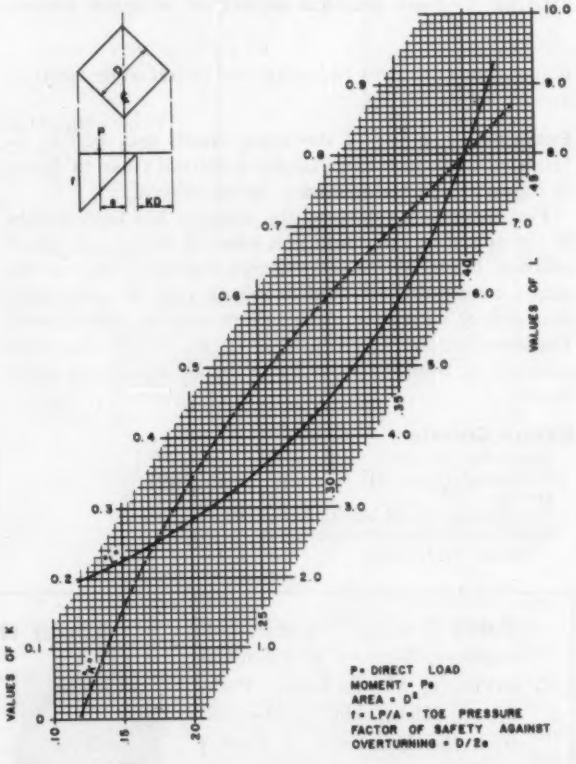

FIGURE 5—This chart is derived from the basic, maximum soil pressure formula, $f = \frac{P}{A} + \frac{Mc}{I}$.

Charts for rectangular and other shaped footings may be prepared by following a similar procedure to that used in the development of these charts. Only the sizes normally encountered in a particular practice need be included. ##

New Method for V/L Flash Calculations

Introduction of another variable reduces trial and error in vapor liquid flash calculations.

Royes Salmon
Houdry Process Corporation, Philadelphia*

THESE PROCEDURES are designed to reduce trial and error in certain types of vapor-liquid equilibrium calculations.

The first method is useful when a make-up gas stream enters the system, in addition to the main feed.

The second method is applicable where the vapor phase from the flash is recycled through a scrubbing system back to the flash drum with one component being continuously removed.

First Method. Normally, various values of V/L are tried and discarded, until one is found which satisfies the equilibrium relationships. Instead this method makes all the trial values of V/L valid, by adding the proper amount of the make-up stream for each value. The amount of make-up needed in each case is found by a simple calculation. Each trial, therefore, gives the equilibrium compositions at a certain make-up rate. This procedure is illustrated as follows:

Example 1—The components entering the flash drum, and their respective K values, are given as follows (exclusive of the make-up component):

COMPONENT	Feed Mols	K
A	10	5
B	15	1
C	10	0.1
D	65	0.01

The make-up stream in this example is pure hydrogen.

First flash the feed at some assumed V/L, say 0.20. A conventional method is used, in which L is found by calculating $\frac{F}{1 + K\,V/L}$

Assume $V/L = 0.20$

Component	Feed Mols	K	K V/L	1 + K V/L	L	V
A	10	5	1	2	5.000	5.000
B	15	1	.2	1.2	12.500	2.500
C	10	0.1	.02	1.02	9.804	0.196
D	65	0.01	.002	1.002	64.870	0.130
	100	....	....	....	92.174	7.826

$$(V/L)_c = \frac{7.826}{92.174} = 0.0849$$

Now calculate how much make-up hydrogen must be added in order to reach the assumed V/L of 0.20.

This is done as follows: Assume a basis of one mol of hydrogen. Calculate a flash on this hydrogen at the assumed V/L of 0.20:

	Feed Mols	K	K V/L	1 + K V/L	L	V
H_2	1	25	5	6	0.1667	0.8333

If we let M be the mols of hydrogen to be added, then the liquid phase will be increased by 0.1667 M, and the vapor phase will be increased by 0.8333 M.

Then, since V/L is to be 0.20,

$$\frac{V}{L} = \frac{7.826 + 0.8333\,M}{92.174 + 0.1667\,M} = 0.20$$

from which M = 13.26 mols.

It should be pointed out here that the component being added must have a K value different from 1, in order to make this calculation possible.

The calculation can now be repeated at other values of V/L. For example, at a V/L of 0.10, we get M = 6.79 mols, and at a V/L of 0.30, we get M = 20.15 mols.

In some cases, the hydrogen concentration in the recycle gas may be of interest. This concentration can be calculated at each value of V/L. At a V/L = 0.20, the total vapor is 7.826 + 0.8333 M, or 18.876 mols. The hydrogen in the vapor is 0.8333 M or 11.050 mols. The hydrogen concentration then is $\frac{11.050}{18.876}$, or 58.5 percent.

In the same manner, the hydrogen concentration at a V/L of 0.10 is 49.9 percent, and at a V/L of 0.30, it is 64.1 percent. Hydrogen concentration can now be plotted against the hydrogen make-up rate. This is shown in Figure 1.

Example 2—The same procedure is followed if the make-up stream contains several components. Using Example 1, assume this make-up composition:

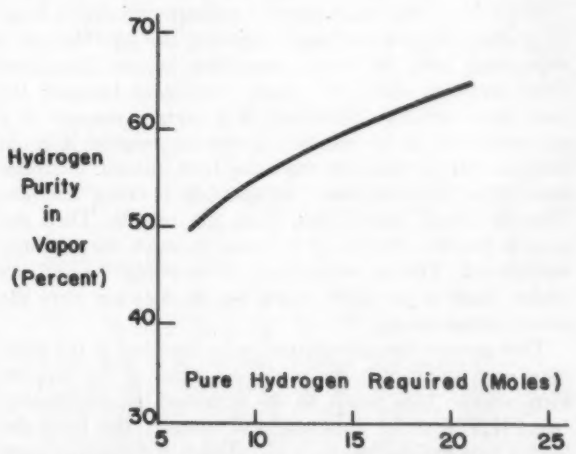

FIGURE 1—Hydrogen Purity as a function of make-up rate.

* Present address: Union Oil Company of California, Brea, Calif.

COMPONENT	Mol Percent	K
H_2	97	25
P	2	5
Q	1	2
	100	..

then the flash on the make-up at a V/L of 0.20 would be as follows:

Component	Feed Mols	K	K V/L	1 + K V/L	L	V
H_2	0.97	25	5	6	0.1617	0.8083
P	0.02	5	1	2	0.0100	0.0100
Q	0.01	2	.4	1.4	0.0071	0.0029
	1.00	..	....	..	0.1788	0.8212

Letting M be the total mols of make-up to be added, we have:

$$\frac{V}{L} = \frac{7.826 + 0.8212\ M}{92.174 + 0.1788\ M} = 0.20$$

From which M = 13.51 mols.

Second Method

Recycling any amount of either phase back to an equilibrium flash does not alter the composition of either phase, although the V/L ratio is changed. Thus, when flash vapor is recycled, the flash ordinarily is calculated without including the recycle.

However, if the recycle is scrubbed to remove one component, this procedure is no longer valid. The compositions of the phases are definitely affected by the recycle rate.

At first glance, it would seem the way to calculate the flash compositions is to find V/L for the main feed by trial and error, scrub the vapor phase, and thus arrive at a recycle gas composition. This can be added to the feed to recalculate the flash compositions, obtaining a new recycle gas composition, which can be re-combined with the feed for a third trial, and so on.

However, when there are two streams entering a flash, at a given temperature and pressure, the equilibrium is dependent only on the composition of the combined feeds and not upon any given component between the two input streams. Therefore, if a certain amount of a component is to be removed from the recycle, it could just as well be removed from the feed instead. Consider then, that the component in question is being removed from the feed, rather than from the recycle. Then the recycle can be considered as going through the scrubber unchanged. This is equivalent to recycling one of the phases back to the flash drum, which does not alter the phase compositions.

This permits the calculation to be handled in the ordinary way, using only the feed, and ignoring the recycle. First assume how much of the scrubbed-out component (e.g., H_2S) is to be removed, and subtract this from the feed. Upon making the flash calculation, a certain amount of H_2S is found in the vapor phase. Now calculate the amount of recycle needed to make the whole calculation valid:

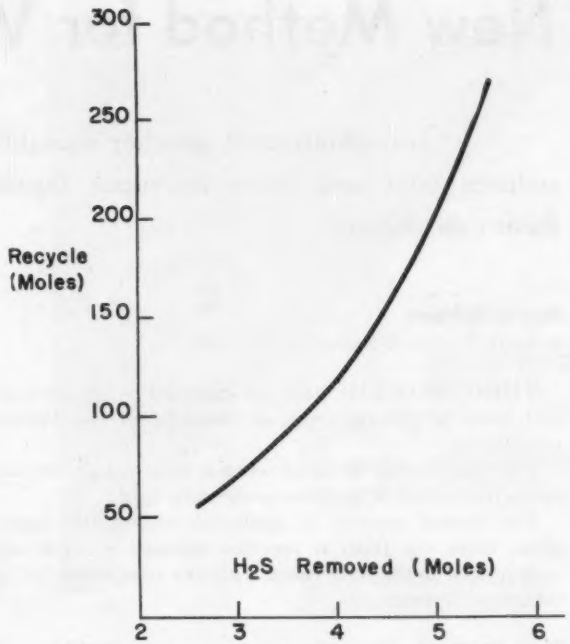

FIGURE 2—Recycle required as a function of H_2S removed.

For example, if the calculated vapor phase contains 5 percent H_2S, and 12 mols of H_2S were subtracted from the feed, then (with 100 percent scrubbing efficiency) the amount of recycle needed is 12 divided by 0.05, or 240 mols. These 240 mols of recycle contain the 12 mols of H_2S which were removed from the feed. Adding this 12 mols back into the feed, and considering it as being removed from the recycle, puts everything back in balance.

Again, if the scrubbing efficiency is 90 percent, the recycle required would be

$$\frac{12}{0.05 \times 0.90}, \text{ or } 267 \text{ mols}$$

In deciding how much H_2S to remove from the feed, use the technique described in the first method. For each assumed value of V/L, the flash is first made without the H_2S. A separate flash is made on the H_2S. A simple equation determines the amount of H_2S needed to make the assumed value of V/L check. This procedure is illustrated by the following example.

Example 3—The feed is as follows:

COMPONENT	Feed Mols	K
H_2	12	25
H_2S	8	0.8
A	10	5
B	15	0.1
C	55	0.01
	100	....

Assume the H_2S is removed from the recycle gas, with a scrubbing efficiency of 97 percent. Assume 100 mols of gas are to be recycled (measured before scrubbing). Find the compositions of the vapor and liquid phases and the amount of H_2S removed.

As a first trial, assume V/L=0.10 calculate the flash without the H_2S:

First Trial: Assume V/L = 0.10

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	2.5	3.5	3.429	8.571
A	10	5	0.5	1.5	6.667	3.333
B	15	0.1	0.01	1.01	14.851	0.149
C	55	0.01	0.001	1.001	54.945	0.055
	92	.....	.....	.....	79.892	12.108

$$(V/L)_c = 0.1516$$

Now, using the first method, calculate how much H_2S is needed to make the assumed V/L valid.

The flash on one mol of H_2S is as follows:

	F	K	K V/L	1 + K V/L	L	V
H_2S	1	0.8	0.08	1.08	0.9259	0.0741

Let M be the mols of H_2S needed. Then

$$\frac{12.108 + 0.0741\ M}{79.892 + 0.9259\ M} = 0.10$$

$$M = 222.8 \text{ mols}$$

This is greater than the total H_2S in the feed, and so is impossible.

For the next trial, assume V/L = 0.25:

Second Trial: Assume V/L = 0.25

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	6.25	7.25	1.655	10.345
A	10	5	1.25	2.25	4.444	5.556
B	15	0.1	0.025	1.025	14.634	0.366
C	55	0.01	0.0025	1.0025	54.863	0.137
	92	.....	.....	.....	75.596	16.404

$$(V/L)_c = 0.1763$$

The flash on one mol of H_2S is:

	F	K	K V/L	1 + K V/L	L	V
H_2S	1	0.8	0.20	1.20	0.8333	0.1667

$$(V/L)_c = 0.20$$

Obviously, we cannot raise the V/L to 0.25 by adding material with a V/L of 0.20. So for the next trial, assume a lower V/L.

Third Trial: Assume V/L = 0.20

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	5	6	2.000	10.000
A	10	5	1	2	5.000	5.000
B	15	0.1	0.02	1.02	14.706	0.294
C	55	0.01	0.002	1.002	54.890	0.110
	92	.....	.....	.....	76.596	15.404

$$(V/L)_c = 0.2011$$

The flash on one mol of H_2S is:

	F	K	K V/L	1 + K V/L	L	V
H_2S	1	0.8	0.16	1.16	0.8621	0.1379

$$(V/L)_c = 0.16$$

The amount of H_2S needed is found as before:

$$\frac{15.404 + 0.1379\ M}{76.596 + 0.8621\ M} = 0.20$$

$$M = 2.46 \text{ mols of } H_2S \text{ needed.}$$

Then H_2S in vapor = (0.1379) (2.46) = 0.339 mols

Total vapor = 15.404 + 0.339 = 15.743 mols

H_2S removed = 8 — 2.46 = 5.54 mols

$$\text{Recycle required} = \frac{(15.743)\ (5.54)}{(0.339)\ (0.97)} = 265 \text{ mols}$$

Now start plotting recycle against mols of H_2S removed, to find the amount of H_2S removed when the recycle is the desired value of 100 mols.

Since the recycle of 265 mols is too high, evidently too much H_2S is removed. Since removing H_2S raises the calculated V/L value, assume a lower V/L:

Fourth Trial: Assume V/L = 0.198

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	4.95	5.95	2.017	9.983
A	10	5	0.99	1.99	5.025	4.975
B	15	0.1	0.0198	1.0198	14.709	0.291
C	55	0.01	0.00198	1.00198	54.891	0.109
	92	.....	.....	.....	76.642	15.358

$$(V/L)_c = 0.2004$$

The flash on one mol of H_2S is:

	F	K	K V/L	1 + K V/L	L	V
H_2S	1	0.8	0.1584	1.1584	0.8633	0.1367

So $$\frac{15.358 + .1367\ M}{76.642 + .8633\ M} = 0.198$$

$M = 5.34$ mols of H_2S needed.

H_2S in vapor = (0.1367) (5.34) = 0.730 mols

Total vapor = 15.358 + 0.730 = 16.088 mols

H_2S removed = 8 — 5.34 = 2.66 mols

$$\text{Recycle required} = \frac{(16.088)\ (2.66)}{(0.730)\ (0.97)} = 60.4 \text{ mols}$$

Fifth Trial: Assume V/L = 0.199

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	4.975	5.975	2.008	9.992
A	10	5	0.995	1.995	5.013	4.987
B	15	0.1	0.0199	1.0199	14.707	0.293
C	55	0.01	0.00199	1.00199	54.891	0.109
	92	.....	.....	.....	76.619	15.381

$$(V/L)_c = 0.2007$$

The flash on one mol of H_2S is:

	F	K	K V/L	1 + K V/L	L	V
H_2S	1	0.8	0.1592	1.1592	0.8627	0.1373

So $$\frac{15.381 + 0.1373\ M}{76.619 + 0.8627\ M} = 0.199$$

From which $M = 3.89$ mols of H_2S needed.

H_2S in vapor = (0.1373) (3.89) = 0.534 mols

Total vapor = 15.381 + 0.534 = 15.915 mols

H_2S removed = 8 — 3.89 = 4.11 mols

$$\text{Recycle required} = \frac{(15.915)\ (4.11)}{(0.534)\ (0.97)} = 126.3 \text{ mols}$$

V/L Flash Calculations . . .

Plotting H_2S removed against recycle gives the curve shown in Figure 2. At a recycle rate of 100 mols, the H_2S removed is 3.64 mols. The correct value of V/L can be found by a similar plot to be 0.1987.

The complete material balance and flash calculation for this case is obtained as follows:

1.—Check the flash at a V/L of 0.1987:

H_2S removed = 3.64 mols.

	F	K	K V/L	1 + K V/L	L	V
H_2	12	25	4.9675	5.9675	2.0109	9.9891
H_2S	4.36	0.8	0.15896	1.1590	3.7620	0.5980
A	10	5	0.9935	1.9935	5.0163	4.9837
B	15	0.1	0.01987	1.0199	14.7078	0.2922
C	55	0.01	0.001987	1.0020	54.8909	0.1091
	96.36	....	.....	.....	80.3879	15.9721

$$(V/L)_c = 0.1987$$

$$\text{Recycle required} = \frac{(15.97)\ (3.64)}{(0.598)\ (0.97)} = 100.2$$

2.—Ratio the vapor phase up to 100.2 mols to obtain the actual unscrubbed recycle. Remove 97 percent of the H_2S, noting that this checks the assumed value of 3.64 mils. This gives the actual scrubbed recycle. Then add the scrubbed recycle to the actual feed to obtain the total material actually entering the flash drum:

	Actual Unscrubbed Recycle	H_2S Removed	Actual Scrubbed Recycle	Original Feed	Actual Total Material to Flash Drum
H_2	62.665	....	62.665	12	74.665
H_2S	3.752	3.640	0.112	8	8.112
A	31.265	....	31.265	10	41.265
B	1.833	....	1.833	15	16.833
C	.684	....	0.684	55	55.684
	100.199	3.640	96.559	100	196.559

3.—Flash this total material at the actual V/L. This is calculated by taking the V/L already obtained and correcting it for recycle. This is easier to see if the hypothetical case is used where the H_2S is removed from the feed rather than from the recycle. The total V/L is not affected by this assumption. The unscrubbed recycle (100.2 mols) adds to the vapor phase, and the liquid phase is unchanged. The new V/L, therefore, is:

$$V/L = \frac{15.972 + 100.2}{80.388} = 1.4451$$

Using this value of V/L, the actual flash on the total material entering the flash drum is as follows:

	Actual Total Feed	K	K V/L	1 + K V/L	Actual Liquid	Actual Total Vapor
H_2	74.665	25	36.1275	37.1275	2.011	72.654
H_2S	8.112	0.8	1.1561	2.1561	3.762	4.350
A	41.265	5	7.2255	8.2255	5.017	36.248
B	16.833	0.1	.14451	1.1445	14.708	2.125
C	55.684	0.01	.01445	1.01445	54.891	.793
	196.559	....	.....	.....	80.389	116.170

$$(V/L)_c = 1.4451$$

Thus, the calculated V/L checks the assumed V/L.

4.—To complete this check, the total actual vapor phase can be ratioed into two portions, one of which is equal to the actual net vapor phase (see 1), and the other equal to the actual unscrubbed recycle (see 2). This is shown below:

	Total Vapor		Net Vapor		Unscrubbed Recycle	
	Mols	Mol Fractions	Mols	Mol Fractions	Mols	Mol Fractions
H_2	72.654	.6255	9.989	.6255	62.665	.6255
H_2S	4.350	.0374	0.598	.0374	3.752	.0374
A	36.248	.3120	4.984	.3120	31.264	.3120
B	2.125	.0183	0.292	.0183	1.833	.0183
C	0.793	.0068	0.109	.0068	0.684	.0068
	116.17	1.0000	15.97	1.0000	100.198	1.0000

Applications—Observe that both methods employ the same basic idea. Instead of making a calculated V/L match an assumed V/L, some other function is made to converge upon a desired value. The first method used the amount of make-up component for this purpose; the second method used the recycle rate.

The amount of make-up was plotted against some other variable, such as hydrogen concentration, V/L ratio, etc., in the first method. This same principle can be used even with no actual make-up. For example, in catalytic reforming, the amount of hydrogen produced could be used as the make-up variable, either with or without its associated methane, ethane, and propane. Then hydrogen make in standard cubic feet per barrel of feed could be plotted against hydrogen purity in the recycle gas.

Any component (or group of components) can be used as the make-up stream. Nor does it matter whether it enters or leaves the system. That is, it may be subtracted rather than added.

The chief application of these methods is in process design studies involving economic decisions, where information must be developed in the form of curves relating the variables, and a single point would be insufficient.

NOMENCLATURE

K = Vaporization equilibrium constant
L = Mols of liquid at equilibrium
V = Mols of vapor at equilibrium
M = Mols of component to be added to make flash calculation balance
$(V/L)_c$ = Calculated value of V/L

About the Author

ROYES SALMON, senior process engineer at Houdry Process Corporation in Philadelphia, graduated from Cooper Union Institute of Technology, New York, with a B.S. degree in chemical engineering. From 1944-48 he worked as process design engineer with Foster Wheeler Corporation. In 1948 he joined Union Oil Company of California where he worked until 1957 as senior process engineer in long range planning, process design, economics and plant operations.

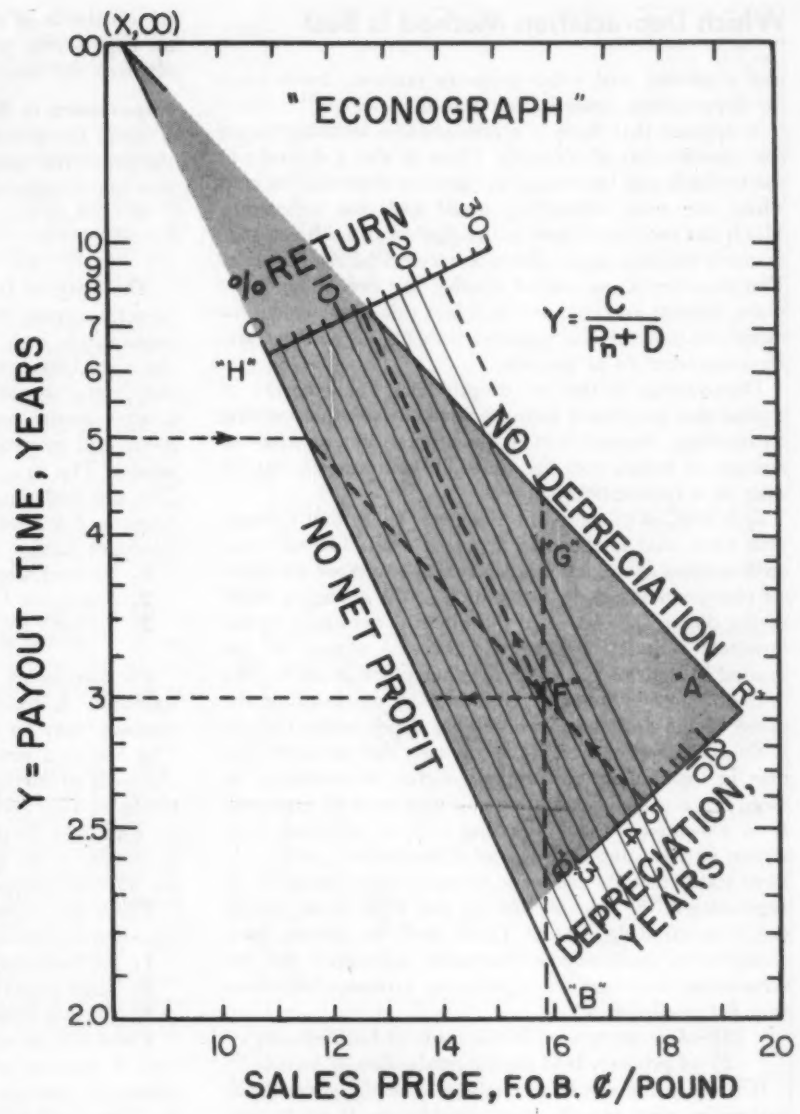

FIGURE 1—The "Econograph" is useful in determining profits for various ventures without resorting to tables and long mathematical formulas.

Here seven different depreciation methods are analyzed and compared. With rising costs and continuing inflation, some departures from present thinking are necessary to determine . . .

Which Depreciation Method Is Best

B. J. Gaffney
The Rust Engineering Company, New York City

A THOROUGH TREATMENT of depreciation as a subject might constructively require many hundreds of pages. The subject matter, even restricted as the title implies, has many facets. All of these are not to be explored here.

The limited purpose here is to bring forth some of the thinking in the field of cost engineering; to present the generalized mechanics and limitations of depreciation calculations; to briefly explore the profit statistics of industry; and to pose different concepts of depreciation effects in project evaluations. The effect of inflation on replacement is considered.

Equations for the generally accepted depreciation methods are herein developed. Also derived is a new equation incorporating a declining balance principle. The new method of the author is called Sum of Percentages. This would, if adopted, permit faster write-offs. It seemingly satisfies an accepted past concept that, to date, has not been fully applied.

Depreciation Concepts. Financial reports give many captions for what must be generally classified as "depreciation." The American Institute of Accountants[1] acknowledges the ambiguity of the situation. It recently made a list of various terms used.

These included *"reserves for depreciation; reserves for depreciation and amortization; reserves for depreciation, amortization, and retirement; reserves for depreciation*

and depletion and other property reserves; less-reserves for depreciation, amortization and obsolescence."

It appears that there is a non-uniform attitude toward the classification of accounts. There is also a diversity in the methods and bases used to calculate depreciation costs which are now entered in profit and loss statements. Much has been published in the past on this subject, particularly on long range effects of accelerated depreciation. The situation is not one of apathy, but one of great activity, interest and concern. It is into this management atmosphere that the cost engineer presents his analyses and recommendations of projects.

Depreciation is the act of providing for recovery of capital that purchased physical assets. By strict accounting terminology, depreciation is the process of allocating an amount of money over the useful life of a tangible capital asset in a systematic manner.

It is cost, as of some one time, not value that changes with time, that is allocated and recovered. The unrecovered amount is the unamortized cost. There are no interest charges nor is there recognition of the changing value of the dollar. The value of the physical asset may be determined if it is marketable. Otherwise it may be appraised in light of the value of other physical assets. The initial figure entered in the books as representing the value of the asset less accumulated depreciation charges is the unamortized cost. It is this cost that presently figures in income tax calculations, rightly or wrongly. As such, it is a prepaid operating cost that must be expensed. It is allocated to the operating expense account. One writer, in discussing the vagaries of the subject, goes so far as to state "nobody can write an acceptable definition of depreciation." [13] Section 167 of the 1954 Code, under (a) General Rule, states "There shall be allowed as a depreciation deduction a reasonable allowance for the exhaustion, wear and tear (including a reasonable allowance for obsolescence)—

(1) of property used in the trade or business, or

(2) of property held for the production of income."

It is up to the owner to establish with the government authorities what constitutes reasonableness. It might well be that cost engineers have heretofore not played as large a role as seems necessary to provide the basis for negotiating such decisions.

Marston, et al[10] aptly point out "those who write about depreciation have failed to make clear the distinction between depreciation as an item of cost allocation and depreciation as a measure of the consumed usefulness of property." Foulke's book, "Practical Financial Statement Analysis",[11] points out that the rate of depreciation, based on life expectancy of an asset, is an engineering, rather than an accounting, problem. There is sensibly a difference in the attitude of treatment from a strict accounting viewpoint and that of engineering decision making. The elements of expression are, however, inextricably bound.

Judgment is needed as to:

1. Time of depreciation to be applied on various types of fixed assets.
2. The manner and mechanics of application.

In analyzing projects an engineer must recognize the relative value of physical assets. This is as true in evaluating any asset as of a given time as it is in comparing alternate assets as of one date. The physical life of an asset is an engineering problem, but the danger of obsolescence obscures the issue.

Importance in Decision Making. Profits after taxes are a must. The greater the depreciation charge for any year the lower the taxes and the greater the capital conservation in depreciation reserves. Consider the equations,[12]

$$P_n = (x_p y_p - S - x_k y_k - D - E - I)\ (1\text{-}t) \qquad (1.0)$$

$$Y = \frac{C}{P_n + D} \qquad (1.1)$$

The value of D limits the profits to the stockholders or owners, as may be seen graphically in Figure 1.[12] if it is inordinately high the principal will be overprotected for the particular period; if it is too low part of the profits distributed would rightfully be capital money. This is a relative matter and gives rise to opinions of understatement and overstatement of profits. This is a cash-flow matter. The sum of P_n and D is the total cash recovery. The size and time of distributions are important considerations. For consideration of new projects the following estimates need to be made:

1. Erected Cost.
2. Operating Capital and Costs.
3. Life of: a) Physical assets,
   b) Process.

For forecasting these the cost engineer is primarily responsible. A fourth estimate, the market value of the product, may be his responsibilty, directly or indirectly. The life of a process may be influenced by competitive materials or methods. Forecasting, however difficult, is a necessary function if the worth of capital projects is to be appraised. Depreciation is related to erected cost and to the life of the project, and to the independent lives of the various equipment that make up the project plant.

There are, in every project, certain costs that can be expensed immediately, such as:

1. All expenditures for non-physical assets.
2. Some physical assets of extremely short life.
3. Certain installation and starting-up expenses.

There are, in some cases, capital wastages from depletion of mineral or other deposits. Such depletion is calculated in relation to the current dollar value of the product. Land, per se, is excluded unless it be finally disposed. Thus, oil companies enter depletion charges that are based on existing oil market values. The value at time of purchase is not the criterion. Some companies use straight-line depreciation with yearly adjustments proportioned to some measure of productivity or gross revenue for both income tax and corporate purposes. Utilities and at least one synthetic fibre manufacturer have reportedly used such irregular methods.

All the above forecasts should sensibly be defined in terms of reliability. Statistical interpretations are becoming increasingly important. In a recent article[16] predicting development costs, statistical techniques are applied in the formulation of an estimating system for forecasting costs. Another deals with plant mortality.[17] This presents an approach to determining the life expectancy of equipment by analyzing the frequency distribution of failures. Thus, in some instances the life of physical assets may be forecast in terms of statistical expressions. Actuaries have applied themselves diligently to this subject. But there are many factors to consider which influence the economic life, such as:

1. Physical obsolescence caused by wear and tear, corrosion and such factors which impair operating efficiency or safety to a point of economic undesirability.
2. Process or product obsolescence caused by developments rendering the process, or equipment, uneconomic in terms of performance.
3. Governmental, or other, actions which develop to prevent operation; e.g., loss of raw material source, or a new law prohibiting waste disposal, and any number of other possibilities.

The preponderance of such factors should beg the question "What is the realistic approach to the preparation of a time-money schedule for depreciation costs in engineering cost studies and project analyses?" One will find a diversity of opinion ranging from writing-off the capital outlays in the first year to writing these off at the end of economic or useful life. Using the sum of the digits method of computing depreciation, one is not permitted to write-off capital assets in less than three years. Seemingly, this makes three years the minimum time for any method under present regulations.

Depreciation is a factor in the determination of profit after taxes. The Federal government is not static in its policy with regard to depreciation reductions, nor to tax rates as evidenced in Figure 3. The excess profit tax is not incorporated in the plotted figure.

Depreciation Methods. If one disregards the time-value of money, the initial cost of a project can be recovered in depreciation reserves by various means of scheduling. The fundamental problem is to derive equations to represent the manner in which the initial capitalized assets decrease to salvage value. The latter may assume a positive or negative value, or may equal zero.

Figure 3 depicts several depreciation possibilities. The value C_o is that of the initial cost on which depreciation is to be taken. The cost is assumed at year y_o. The value C_e is the value of the physical assets of original value C_o at time y_e (the life of these assets).

Straight Line. The straight-line depreciation may be expressed as:

$$C_o - C = \left[\frac{C_o - C_e}{y_e}\right] y \qquad (2.0)$$

and the rate of depreciation D at any time by:

$$D = \frac{-dC}{dy} = \frac{C_o - C_e}{y_e} = \text{a constant} \qquad (2.1)$$

Here, as elsewhere, C_e may assume zero or other value. See Figure 2.

A method known as "Declining Balance" has a long history in other countries, notably in the British Empire. In the U. S., interest in this method increased when the new provisions in the Internal Revenue Code of 1954 became effective. In cases where the earning power of the acquired asset is greater in its early life, this method tends to allocate costs in that direction.[3] As with all other methods, there is no one reason for the exact form taken. It is judged by some to be in the direction of fulfilling a need. Such methods are characterized by an amount, proportionally greater than that in the straight line method, being written-off in the early life of the asset. They have

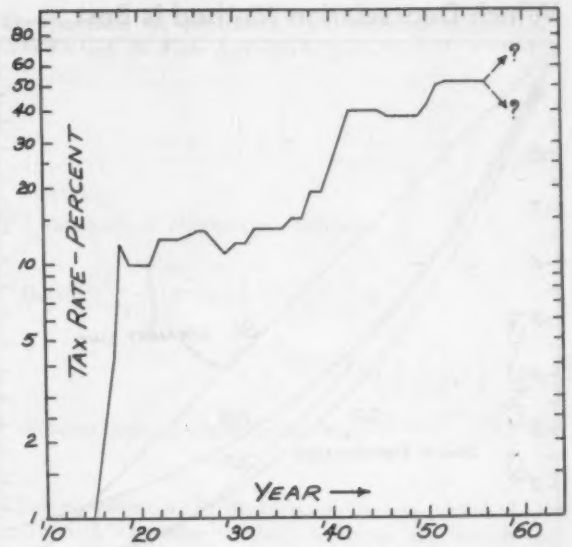

FIGURE 2—Plots the corporate tax rate for industry over the years.

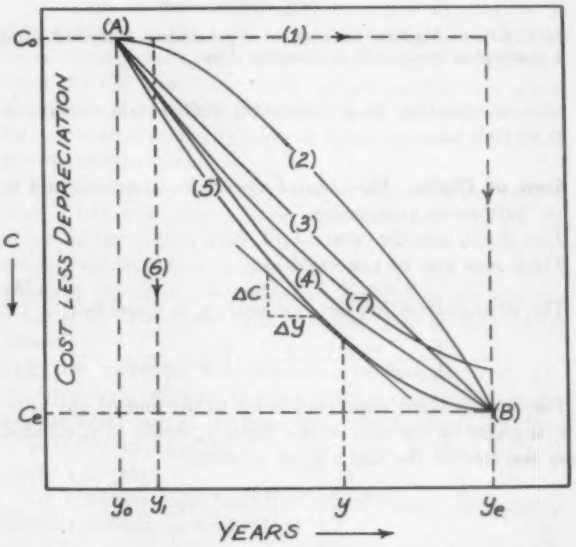

FIGURE 3—Several depreciation possibilities. C_o is the initial cost on which depreciation is to be taken. This cost is assumed at year y_o. The value C_e is the value of the physical assets of original value C_o at time y_e (the life of these assets). Path (1) represents a "retirement method," where no depreciation is charged for the fixed assets while they remain in service. The entire original cost C_o is charged as expense in the year of its retirement. A "replacement method" would follow the same path. However, here the charge to expense would be the cost of a replacement at the time y_e. Such cost could be greater, less, or equal to the initial cost C_o. A method such as the "sinking fund" would be characterized by a curve of the general path numbered (2). This visualizes uniform deposits at the end of each year which are compounded at some interest rate. Path (6) describes a method one author describes as "cash-flow write-off." Here the total cost would be rettred by the end of the first year. The methods to be treated here are characterized by curves (3), (4) and (5). Curve (3) is the straight line that characterizes that type of depreciation. Multiple straight-line is another practice. Curve (5) represents a number of different types, such as "declining balance," "sum of the digits." Variations of these methods will be defined. Curve (7) is the declining balance method as practiced with residual value other than C_e, Curve (4) would be realized from application of types (3) and (5) over different intervals, or from a change of rate for any type within the life period.

Which Depreciation Method Is Best . . .

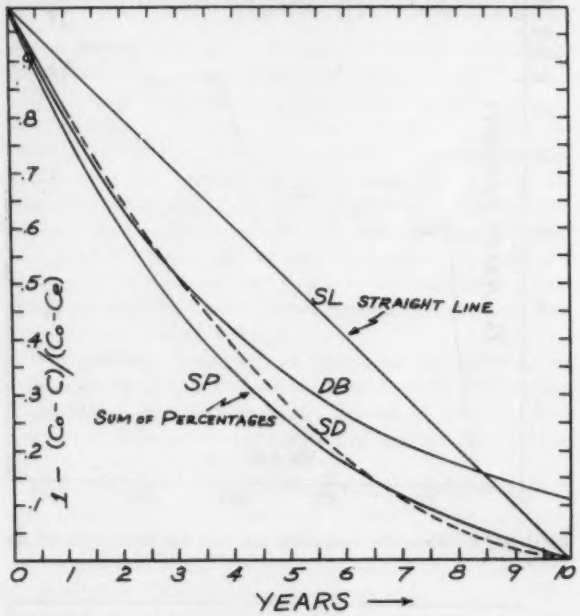

FIGURE 4—Various methods of depreciation compared using a continuous curve with a changing slope.

been accepted by the government, with certain restrictions as to their use.

Sum of Digits. The sum of the digits is represented by an "arithmetic progression."

The digits are the years 1, 2, 3, ... y_e

Their sum can be expressed as:

$$S = y_e + \tfrac{1}{2}\, y_e\, (y_e - 1) \qquad (3.0)$$

The depreciation for any one year, y, is given by:

$$\left[\frac{y_e + 1 - y}{y_e + \tfrac{1}{2}\, y_e\, (y_e - 1)}\right](C_o - C_e) \qquad (3.1)$$

The accumulated depreciation up to the end of any year, y, is given by the sum of the digits y_e down to y, divided by the sum of the digits y_o to y_e, thus:

$$C_o - C = \frac{y_e\, y - \tfrac{1}{2}\, y\, (y - 1)}{y_e + \tfrac{1}{2}\, y_e\, (y_e - 1)}(C_o - C_e) \qquad (3.2)$$

which can be rearranged as:

$$\frac{C_o - C}{C_o - C_e} = \frac{y}{y_e}\left[\frac{2\, y_e - y + 1}{y_e + 1}\right] \qquad (3.3)$$

The expression on the right is the cumulative depreciation for an asset of value one (1), i.e., 1 = Initial cost less salvage value.

The depreciation rate at any one time, y, is given by:

$$D = \frac{-\,dC}{dy} = \left[\frac{2\,(y_e - y) + 1}{y_e\,(y_e + 1)}\right](C_o - C_e) \qquad (3.4)$$

Sum of Digits—A Variation. A variation of this method, based on taking percentages of unrecovered cost, is also being practiced.[5] The fraction applied to $(C - C_e)$ to obtain the depreciation for the year y is formed by determining:

a) the years remaining,
b) the sum of the years up to and including the year of depreciation.

The depreciation for any one year is thus:

$$C_y - C_{y-1} = \frac{y_r}{(y_r/2)\,(1 + y_r)}(C - C_e) = \frac{2}{1 + y_r}(C - C_e) \qquad (4.0)$$

where, y_r = years remaining = $y_e - y + 1$
= original expected life, less the year of depreciation + 1 (4.1)

Here a changing percentage is applied to a changing unrecovered cost. Substituting the expression for y_r in equation (4.0),

$$C_y - C_{y-1} = \frac{2\,(C - C_e)}{2 + y_e - y} \qquad (4.2)$$

By successive application of equation 4.2 it may be shown that,

$$(C - C_e) = (C_o - C_e)\frac{(y_e - y)!}{(y_e + 2 - y)!} \qquad (4.3)$$

However, it will be noted that in the expansion starting with year 3, a number of the terms to be multiplied are identical in numerator and denominator.

For year 3, $(y_e - 1)$ may be divided out; for year 4, $(y_e - 2)$ may be divided out, and so on. Thus another more usable form of expression is found to be:

$$(C - C_e) = (C_o - C_e)\frac{(y_e - y + 1)\,(y_e - y)}{(y_e + 1)\,y_e} \qquad (4.4)$$

From this it can be shown that:

$$\frac{C_o - C}{C_o - C_e} = \frac{y\,(2\,y_e - y + 1)}{(y_e + 1)\,y_e} \qquad (4.5)$$

This is the identical expression for the usual sum of digits, applied to original cost less salvage value, i.e., equation (3.3).

Declining Balance. Another method, that of Declining Balance, is one also used by a number of companies. The procedure is one of applying a fixed percentage to the value $(C - C_e)$. This presents some problems, since the asset can never be depreciated to zero value. There is a textbook formula given as:

$$x = 1 - \sqrt[y_e]{\frac{C_e}{C_o}} \qquad (5.0)$$

which, for any positive salvage value, defines an appropriate value of x. One cannot select a value of x independently of salvage value. Also, a salvage value of zero would predicate that the write-off be completed in the first year!

But the principle, in part, is widely practiced, usually by applying a selected fixed percentage to C, rather than $(C - C_e)$, year after year until year y_e.

At year y_e the value on the books is written-off as a "loss" or as an additional depreciation expense. Here is an example of applying a percentage to initial cost value rather than to initial cost less salvage. The allowable depreciation is not realized except by adjustment in the last year.

Sum of Percentages Method. Consider the following development where some percentage x (expressed as a fraction) is defined as the yearly depreciation divided by cost prior to depreciation, thus:

$$x = \frac{C_1 - C_2}{C_1} \qquad (6.0)$$

The tabulation would be as follows:

At End of Year	Depreciation for that year	Remaining Value $(C - C_e)$	
1	$x\,(C_o - C_e)$	$(1-x)\,(C_o - C_e)$	(6.1)
2	$x\,(1-x)\,(C_o - C_e)$	$(1-x)^2\,(C_o - C_e)$	(6.2)
3	$x\,(1-x)^2\,(C_o - C_e)$	$(1-x)^5\,(C_o - C_e)$	(6.3)

and the summation of reserves for depreciation over the years is given by:

$$\sum = (C_o - C_e)\,x\,[1 + (1-x) + (1-x)^2 + \cdots + (1-x)^{y-1}] \tag{6.4}$$

But the sum, at time y_e, must equal $(C_o - C_e)$, and thus x is defined by the equation:

$$1 = x\,[1 + (1-x) + (1-x)^2 + \cdots + (1-x)^{y_e-1}] \tag{6.5}$$

This is only satisfied if $x \equiv 1$

The principle invoked above is that of applying a changing percentage, in fraction form, to the initial capitalized cost less salvage value. In this respect the principle is similar to the Sum of the Digits method. The development to this point, however, does not satisfy the basic requirement that the sum of the increment of depreciation over the period y_e must total to a value of $(C_o - C_e)$.

If we let:

$$1 = kx\,[1 + (1-x) + (1-x)^2 + \cdots + (1-x)^{y_e-1}] \tag{6.7}$$

then x can assume any of the desired values and the k may be determined to satisfy the equality. The ratios of depreciation for respective years will remain as before, which was the feature apparently desired. Moreover, now the capitalized cost may be depreciated to any value C_e including zero value. Thus,

$$C = C_o - k\,(C_o - C_e)\,x\,[1 + (1-x) + (1-x)^2 + \cdots + (1-x)^{y-1}] \tag{6.8}$$

and,

$$\frac{C - C_o}{C_o - C_e} = -kx\,[1 + (1-x) + (1-x)^2 + \cdots + (1-x)^{y-1}] \tag{6.9}$$

The bracketed series of equations 6.7 and 6.9 are geometric progressions whose sums are respectively,

$$\frac{1 - X^{y_e}}{1 - X} \text{ and } \frac{1 - X^{y}}{1 - X} \text{ where } X = 1 - x$$

Making these substitutions and introducing the value of k from equation (6.7) into equation (6.9) it is found that:

$$\frac{C_o - C}{C_o - C_e} = \frac{1 - X^y}{1 - X^{y_e}} \tag{6.10}$$

This is the general expression for the Sum of Percentages Method.

Now the rate of depreciation for this Sum of Percentages Method is given by:

$$D = \frac{-dC}{dy} = \left[\frac{C_o - C_e}{1 - X^{y_e}}\right][X^y \ln X] \tag{6.11}$$

Comparison of Methods. The average depreciation rate for any of these methods is given by:

$$D_{av} = \frac{1}{y_2 - y_1}\int_{y_1}^{y_2}\left(\frac{-dC}{dy}\right)dy \tag{6.12}$$

For the Sum of Percentages Method:

$$D_{av} = \frac{1}{y_2 - y_1}\int_{y_1}^{y_2}[X^y \ln X]\left[\frac{C_o - C_e}{1 - X^{y_e}}\right]dy$$

$$= \frac{X^{y_2} - X^{y_1}}{y_2 - y_1}\left[\frac{C_o - C_e}{1 - x^{y_e}}\right] \tag{6.13}$$

$$\text{Whence annual depreciation} = \frac{x\,(1-x)^{y-1}\,(C_o - C_e)}{1 - X^{y_e}} \tag{6.14}$$

From equation (6.13) depreciation for any period may be calculated. The other methods integrate into similar convenient expressions. However, for finding accumulated depreciation from time y_o to y, when $y_o = 0$, the equations of $(C_o - C)/(C_o - C_e)$ may be equally well used.

Although in accounting practice there appear to be some oddities in the treatment of depreciation over fractional yearly times, the development here is straightforward. In the above equations, y may assume any whole or fractional number. However, as a point of interest, there are some salient features of these methods which are worth consideration.

The time taken for any period of depreciation, be it a year, a half-year, a month or other unit, will change the shape of the depreciation curve. The problem is met in annuity tables where a given percentage per year gives different values of present value, depending on whether the unit of time is one year, one half-year or some other value.

If the half-year convention is to be practiced, i.e., charging only one half of a year's depreciation during the first calendar year of the manufacturing facility's life, then it would seem sensible to let the units of time be y/2, where y is years.

To conform with this for the Sum of Percentages Method one can write:

$$\frac{C_o - C}{C_o - C_e} = \frac{X^{y_o} - X^{y}}{X^{y_o} - X^{y_e}} \tag{6.15}$$

Where y_o can be the one-half year or other initial value.

Graphical Comparison. To show the relative effects of using the different methods, Figure 4 was constructed. The conventional declining balance method is based on a percentage of the original cost C_o rather than C_o less salvage value, i.e., $(C_o - C_e)$. It thus takes a rate on an amount in excess of that which is to be depreciated.

The Sum of Percentages (SP) method is seen to give a faster write-off than any of the other methods, up to two thirds of time of life, y_e. At this point the Sum of Digits (SD) exceeds it. One might argue that the present government ruling prohibits a write-off for the first year greater than twice the Straight Line (SL) method. If this restriction were strictly conformed with the Sum of Percentages method still gives a greater total depreciation over the life than the Declining Balance (DB), and still

exceeds the Sum of Digits in the early years of life. The latter seems to suit the wishes of some manufacturers.

Some values are tabulated for ready comparison in Table 1. It is seen that the Sum of Percentages Method is superior in fast write-off to the Declining Balance method. It provides a rational procedure without any end adjustments being necessary. Moreover, it is suitable for any positive, negative or zero dollar amount for salvage value; the value of x is not dependent on life y_e as is the Book formula for Declining Balance; and it provides for a faster write-off in the early life of the producing facilities.

TABLE 1
Write-Off Comparison

METHOD	Years to Reach ½ Total Depreciation	Times Faster Than ST	Accumulated Depreciation at ⅔ of Life
SL—Straight Line	5.0	1.0	.666
DB—Declining Balance	*3.1	1.61	.774
SD—Sum of Digits	3.1	1.61	.848
SP—Sum of Percentages	*2.65	1.89	*.867
SP—Sum of Percentages	**2.95	1.70	**.840

* @ x = .20 ** @ x = .169

Using a value of x = .169 in the SP method to determine the depreciation for the first year results in a curve that has a depreciation rate of twice Straight Line. This is equivalent to using a value of x = .20 for the DB method.

Differential and Other Treatment. The rate of depreciation for the Straight Line method is a constant, and the accumulated depreciation is the product of this constant and time. It seems that the government on the one hand recognized depreciation initially on this basis. The slope of the curve was invariant. *Perhaps the concept of the value of an asset changing gradually with time intervals less than a year was not conceived.* However, the rule of half time for the initial year of operation has been long established. The concept of differential rates is herein presented. The equations were derived on the basis of yearly stepwise considerations. They, however, describe a continuous curved line between the initial cost and time, and the salvage value and useful life. As such, the slope changes in a gradual and orderly manner. By so treating, fractional years may be conveniently and rationally calculated. Without so doing, the problem of which rate to take for determining intermediate costs becomes an arbitrary matter. Further, the concept of a continuous curve with a changing slope makes for convenient engineering cost calculations and analyses. See Figure 4.

In the comparison of the different methods, it would seem there is ground in the SP method for using, in the first year, an average depreciation rate which will be greater than the DB method. The rate in the DB method is applied to the initial cost and that of the SP method to initial cost less salvage. The latter is a smaller base and, thus it would seem the allowable rate should be $(C_o/C_o - C_e)$ times as great.

It is interesting to note that for the Sum of the Digits method there is no restriction other than a minimum life of three (3) years. But this SD method does, after a given time, give a greater write-off than the Declining Balance method. It is difficult to rationalize how such diverse methods are acceptable and it is seemingly impossible to presently determine when they should be applied. Nevertheless, the methods can have vitally different effects, especially with tax rates at present levels. One author's views certainly seem very apropos:[6] "Tax treatment of business investments can affect management decisions in two ways:

(1) The wrong way, by inducing management to make decisions on the basis of books kept according to the Treasury's tax rules, and

(2) The economically justifiable way, through measuring the impact of tax payments on the amount and timing of cash flows from individual projects."

Whether or not one agrees with one extreme recommendation of this author of completely writing off the assets in the first year, the preponderance of evidence seems to strongly indicate short lives should be assumed in realistically approaching the matter of project desirability. Also, the matter of being permitted to set aside more adequate reserves to buy replacements is presently very pressing. *The greater the depreciation the greater the cash flow generated. This reduces outside financing which in turn affects the balance sheet. Long term debt can be minimized and a more pleasing financial picture presented to stockholders.*

Moreover, as will be illustrated later, the reasons for selecting a type of depreciation are not readily evident from published information. For short lives the choice of method significantly influences results. The method used by a cost engineer should reflect the policy existing within his company. The cost engineer should contribute to the formation of such policy. Of increasing importance is close cooperation with the financial analyst.

Economic Depreciation (SP Method). In the depreciation method previously illustrated, the depreciation rates are not influenced by the changing value of the dollar. Present tax laws do not incorporate such a provision, but recent news releases indicate efforts to so change these laws.

Below is given a Sum of Percentages method *which gives recognition to the changing dollar value, so as to provide full replacement value at end of useful life,* y_e.

Where the dollar value changes by p percentage per year (as a decimal), the capital invested or its unrecovered portion is changing proportional to $(1 + p)^y$. At the end of the first year, the capitalized cost, on which depreciation is taken, is:

$$(C_o - C_e)\ (1 + p) \qquad (7.0)$$

In a Sum of Percentages development then,

At End of Year	Depreciation that Year	Remaining Value	
1.	$x\ (C_o - C_e)\ (1 + p)$	$(1 - x)\ (C_o - C_e)\ (1 + p)$	(7.1)
2.	$x\ (1 - x)\ (C_o - C_e)\ (1 + p)^2$	$(1 - x)^2\ (C_o - C_e)\ (1 + p)^2$	(7.2)

$$\Sigma = (C_o - C_e)\ x\ [1\ (1 + p) + (1 - x)(1 + p)^2 + (1 - x)^2\ (1 + p)^3 - - -] \qquad (7.3)$$

$$= (C_o - C_e)\ x\ (1 + p)\ [1 + (1 - x)\ (1 + p) + (1 - x)^2\ (1 + p)^2 + - - -] \qquad (7.4)$$

The sum of the increments of depreciation must total to a value of,

$$(C_o - C_e)\ (1+p)^{y_e} \tag{7.5}$$

and the sum of the terms in brackets of equation (7.4) is given by,

$$S = \frac{1-(1-x)^y\ (1+p)^y}{1-(1-x)\ (1+p)} \tag{7.6}$$

for any year, y.
Similar to the previous development, we can define k by

$$(1+p)^{y_e} = kx\ (1+p)\ S \tag{7.7}$$

then,

$$(1+p)^{y_e} = kx\ (1+p)\left[\frac{1-(1-x)^{y_e}\ (1+p)^{y_e}}{1-(1-x)\ (1+p)}\right] \tag{7.8}$$

Here x can assume any value and k may be determined to satisfy the equality.
In general

$$\overline{C} = (C_o - C_e)\ (1+p)^y - kx\ (1+p)\left[\frac{1-(1-x)^y\ (1+p)^y}{1-(1-x)\ (1+p)}\right](C_o - C_e) \tag{7.9}$$

and, substituting the value of k

$$\overline{C} = (C_o - C_e)\ (1+p)^y - (1+p)^{y_e}\left[\frac{1-(1-x)^y\ (1+p)^y}{1-(1-x)^{y_e}\ (1+p)^{y_e}}\right](C_o - C_e) \tag{7.10}$$

This is the equation of what might be called the economic value for the capitalized assets. When $y = y_e$, $\overline{C} = 0$, and accumulated depreciation $= (C_o - C_e)\ (1+p)^{y_e}$.

The salvage value would be selected with a consideration of the changing value of the dollar, as may be presently done. The accumulated depreciation plus salvage should then (by use of equation 7.10) be the required amount to purchase a replacement at year y_e. As a suggestion, the value of "p" could be set by the government and subject to change at some reasonable period, such as half life. In evaluating projects the cost engineer would assume a value based on projection of the historical record.

One reference states[15] that over the last 15 year period there has been an increase in the cost of facilities of approximately 7.0 percent per annum, compounded, and, over the last 10 years, about 8 percent. As an example let us choose the 7 percent figure, and select the same basic problem previously worked out for a number of cases.

Calculating the value of y when $C/(C_o - C_e) = \frac{1}{2}$ and $x = .169$, $p = .07$, and $y_e = 10$, we find $y = 2.3$ years. When $y = 1$, 24.6 percent would be written off, based on $(C_o - C_e)$ or 23 percent based on inflated value. If the restriction to twice the straight line write-off were imposed for the first year, then $x = .153$.

Economic Depreciation (SL Method). There are two concepts that might be used. The replacement value of initial installation at time y_e is $(C_o - C_e)\ (1+p)^{y_e}$, adjusted for salvage. Thus $(C_o - C_e)\ (1+p)^{y_e}/y_e$ might be the depreciation per year, a basis hardly justified. The quantity $(C_o - C_e)$ should be entered in the books to reflect the value at any time y.

Thus the second concept would seem rational. That is, let the value $(C_o - C_e)$ change with time and write off a value of:

$$(C_o - C_e)\ (1+p)^y/y_e \tag{8.0}$$

in any one year.

The sum of depreciation over the years is given by:

$$\frac{C_o - C_e}{y_e}\left[(1+p) + (1+p)^2 + \cdots + (1+p)^y\right] \tag{8.1}$$

But at the end of life

$$(C_o - C_e)\ (1+p)^{y_e} \equiv \frac{C_o - C_e}{y_e}\left[(1+p) + (1+p)^2 + \cdots + (1+p)^{y_e}\right] \tag{8.2}$$

For this equality to hold, the sum of terms in brackets on the right side must satisfy,

$$y_e\ (1+p)^{y_2} = [(1+p) + (1+p)^2 + \cdots + (1+p)^{y_e}] \tag{8.3}$$

Here, the values assigned y_e would determine the values of p. This undesirable situation can be resolved. The solution is identical to that used in the development of the SP method.
Let,

$$(1+p)^{y_e} = \frac{k}{y_e}(1+p)\left[\frac{1-(1+p)^{y_e}}{1-(1+p)}\right] \tag{8.4}$$

Here p can assume any value and k be determined to satisfy the equality. However, k may be eliminated by writing the general expression for value of $\overline{C}$ at any time,

$$\overline{C} = (C_o - C_e)\ (1+p)^y - \frac{k}{y_e}(C_o - C_e)\ (1+p)\left[\frac{1-(1+p)^y}{1-(1+p)}\right] \tag{8.5}$$

and then substituting the value of k.
Thus,

$$\overline{C} = (C_o - C_e)\ (1+p)^y - (C_o - C_e)\ (1+p)^{y_e}\left[\frac{1-(1+p)^y}{1-(1+p)^{y_e}}\right] \tag{8.6}$$

When $y = y_e$, $\overline{C} = 0$ and the accumulated depreciation is then equal to $(C_o - C_e)\,(1+p)^y$

Note that the form is identical to the SP method

where the term $(1 - x)$ contributes to the accelerated depreciation. Here, however, we have only the changing value of the dollar promoting a change in write-off rates and $(1 + p)$ is the contributing term. This perhaps points up the general utility of the Sum of Percentages form of development. In modern business machine practice there should be little trouble systematizing accounting systems to incorporate economic depreciation costs. Equations summarizing principal methods are given in Table 2.

Value and Depreciation. Estimating the value of physical assets is a problem that creeps into the subject of depreciation which by one former definition excluded the concept of purchasing power of currency.

For example, the government decrees that a realistic salvage value be used. It allows that the replacement and maintenance practice that is followed influences the value of salvage. If actual salvage is different from that used in determining depreciation, any excess is reported as income, and any deficit is reported as a loss.

This, then, is another consideration in making an appraisal for an investment. The salvage value must follow some path over the useful life. In times of inflation it might be conceivable to obtain more money for certain assets than the purchase price. For projects of anticipated short lives, the salvage value will be extremely important. With the tempo of new developments in some fields, this must be a real problem. Even when the same equipment might be utilized elsewhere, its relocation, as engineers are fully aware, is a costly item.

In the acquisition of existing property, determination of its value often constitutes a major problem. Here Bulletin F can be applied to the different physical assets. This Bulletin, as mentioned earlier, is being reviewed. Judgement is needed to ascertain what extraordinary obsolescence has been occasioned by process or equipment developments. Any developments which make the existing property relatively non-competitive with present practices affects value. The ways of treating such acquisitions in terms of group and composite methods for depreciation purposes has been well treated elsewhere.[5] Likewise, the subject of double bookkeeping will not be elaborated on here.

However, it is well known that many companies employ different sets of figures for book depreciation and for tax base depreciation. As an example, the book of account might well reflect straight line depreciation, whereas the sum of the years digits will be used for tax purposes.

Another matter not treated here is that of those practices in regard to insurance. To obtain adequate coverage, special provisions must be made to limit the amount of depreciation (rather than trying to maximize it.) Thus again, depreciation bows to what use is to be made of the derived costs. Insurable value is the actual cash value at the time of loss. For insurance purposes the actual cash value (or the present worth) has been generally accepted to mean the present reconstruction cost of a facility less physical depreciation. The problem of changing purchasing value of the dollar is thus recognized. Different indices can be used to project original erected costs to present costs.

In January of this year an Indiana telephone company won a State case that might presage Federal developments, and certainly will arouse nationwide interest. Depreciation cost may now, for that company, be adjusted to reflect changes in the value of currency.

Company Statistics. To give some idea of the important role that depreciation plays in different manufacturing industries, some tables have been prepared by selection of published figures.

In Table 3 there are listed a number of companies and the method of depreciation each uses. The numbers aside the names are the reference numbers used by the American Institute of Accountants in their publication "Accounting Trends and Techniques." It is seen that many major companies are practicing accelerated de-

TABLE 2—Formulae Comparisions for Different Depreciation Methods

Key	Method	Differential Rate $D = \frac{-dC}{dy}$	Annual Depreciation	Cumulative Depreciation
SI	Straight line	$\frac{Co - Ce}{y_e}$	$\frac{Co - Ce}{y_e}$	$\frac{y\,(Co - Ce)}{y_e}$
DB	Declining Balance	$[(1-x)^y \ln (1-x)]\,Co$	$x(1-x)^{y-1}\,Co$	$[1-(1-x)^y]\,Co$
SD	Sum of Digits	$\left[\frac{2(y_e - y) + 1}{y_e(y_e + 1)}\right](Co - Ce)$	$\frac{2}{y_e}\left[\frac{y_e + 1 - y}{y_e + 1}\right](Co - Ce)$	$\frac{y}{y_e}\left[\frac{2y_e - y + 1}{y_e + 1}\right](Co - Ce)$
SP	Sum of Percentages	$X^y \ln X\left[\frac{Co - Ce}{1 - X^{y_e}}\right]$ where $X = 1 - x$	$\frac{X^{y_2} - X^{y_1}}{y_2 - y_1}\left[\frac{Co - Ce}{1 - X^{y_e}}\right]$ for any time interval, or $\frac{x(1-x)^{y-1}(Co - Ce)}{1 - X^{y_e}}$ for annual, and $\frac{xC}{1 - X^{y_e}} = \frac{xC}{1 - (1-x)^{y_e}}$ on undepreciated cost	$\left[\frac{1 - X^y}{1 - X^{y_e}}\right](Co - Ce)$
SP	Sum of Percentages (Economic Depreciation)		$(Co - Ce)\frac{[X(1+p)^{y-1}](1+p)^y[1 - X(1+p)]}{1 - X^{y_e}(1+p)^{y_e}}$	$(1+p)^{y_e}\left[\frac{1 - X^y(1+p)^y}{1 - X^{y_e}(1+p)^{y_e}}\right](Co - Ce)$
SL	Straight Line (Economic Depreciation)		$\frac{(1+p)^{y-1}\,p\,(1+p)^{y_e}(Co - Ce)}{(1+p)^{y_e} - 1}$	$(1+p)^{y_e}\left[\frac{1 - (1+p)^y}{1 - (1+p)^{y_e}}\right](Co - Ce)$

preciation methods. A number make no reference to either basis or method. Many of the companies have diverse operations. Whether the particular method selected suits the industry or combination of industries seems to be a matter for speculation. The oil companies that reported method seem consistent.

In appraising projects, the required rate of return or profit, payout and other indices can not be expected to be identical for all enterprises. The amount of influence of depreciation on the required return would be expected to vary with type of manufacturing facility. Table 4 gives derived values based on the last quarter 1956 figures for a number of industries. These were derived from the "Quarterly Financial Report of U. S. Manufacturing Corporations." Depreciation to net profit before and after taxes ratio, expressed as a percent is given. It is seen from these data that depreciation may range from 10 to 52 percent of net profit before taxes, and from 18 to 79 percent on an after taxes basis.

Table 5, specifically for chemical companies, was prepared to show certain ratios and values.

Referring to a previous article by the author,[12] "payout" was defined by equation (1.1), given earlier. With (D) such a large percentage of (P_n) net profit after taxes, it should be clear that "payout" is heavily dependent on depreciation rates. For the drug and high-priced chemical manufacturers, payout is less dependent on (D) than others. Payout and net profit after taxes are dependent considerations.

The accumulated amount of depreciation, as shown in these tables, would be expected to be in lower ratio than that for a new project. For a company of long standing, either certain major equipment has been written off or lower rates prevail toward the last years of depreciated life. In annual reports, depreciation is the accumulated figure for the many assets, including producing units, utility facilities and others, for which different rates might be expected. It would seem that accelerated depreciation of one form or another must be contributing to some of the high average rates reported.

How repair and maintenance enter in cost engineering considerations is still another subject tied in with life of equipment. This is not developed here. However, in looking over annual reports, one seemingly would find difficulty in correlating depreciation with maintenance and repair costs. It is recognized that the same equipment in the same service may have a different life depending on the upkeep and other local conditions. Companies have different operating philosophies about the capitalization of expenditures and of their write-off.

Required Payout. Various authors including 7,8,13 have written on this subject which requires a consideration of depreciation.

One of the problems on which cost engineers could well afford concentration is improvement in the techniques of analyzing capital investment decisions. A secondary problem is that of presenting the findings in terms that are understandable to management and can be reflected in a pro forma statement.

Certainly viewing a company's return on its invested capital is a way to realistically approach, not a relative figure, but a figure management can work with. Returns after taxes are an important consideration. Today the effects of accelerated depreciation can convert a project

TABLE 3—Choice of Method by Company

	Declining Balance Method
31	American Eucaustic Tiling Co., Inc.
137	The Champion Paper and Fibre Company
220	The Electric Auto-Lite Company
335	Koppers Company, Inc.
351	Link-Belt Company
1	ACF Industries, Inc.
7	Ainsworth Manufacturing Corporation
62	Armco Steel Corporation
322	Jones & Laughlin Steel Corporation
495	Scovill Manufacturing Company
527	J. P. Stevens & Company, Inc.
	Sum-of-the-Years-Digits Method
115	Buffalo-Eclipse Corporation
129	Caterpillar Tractor Company
238	Food Machinery and Chemical Corporation
375	McGraw Electric Company
450	Piper Aircraft Corporation
6	Addressograph-Multigraph Corporation
42	American Radiator & Standard Sanitary Corporation
105	Bridgeport Brass Company
263	The Gildden Company
390	Monsanto Chemical Company
529	Stokely-Van Camp, Inc.
5	Adams-Millis Corporation
	Declining Balance and Sum-of-the-Years-Digits Method
207	Dragon Cement Company, Inc.
	Accelerated Depreciation Methods
47	American Stores Company
64	Armstrong Cork Company
155	Colonial Stores, Inc.
278	The Haloid Company
490	Saco-Lowell Shops
3	Acme Steel Company
222	Elgin Watch Company
336	S. S. Kresge Company
349	Lerner Stores Corporation
362	Marathon Corporation
396	Motorola, Inc.
5	Adams-Millis Corporation
570	United States Steel Corporation
	Production Method
463	The Pure Oil Company
509	Skelly Oil Company
	Straight Line and Production Methods
58	Anderson-Prichard Oil Corporation
61	Argo Oil Corporation
535	The Superior Oil Company
541	Texas Gulf Sulfur Company
545	Tidewater Associated Oil Company
552	Union Oil Company of California
	Various Other Methods
114	The Budd Company
393	John Morrell & Company
514	Shoe Corporation of America
491	The Safety Car Heating & Lighting Company, Inc.

TABLE 4

Depreciation As Percent of Net Profit Before Federal Income Taxes

	Chemical & Allied Prod.	Industrial Chemicals	Drugs & Medicine	Petro. Refin.	Textile Mills	Paper & Allied Prod.
Less Emer. Facs....	24.2	29.0	9.5	48.9	42.3	29.8
Incl. Emer. Facs....	28.6	35.1	10.0	51.8	42.3	31.2
Depreciation as Percent of Net Profit After Federal Income Taxes						
Less Emer. Facs....	44.2	51.5	18.2	55.2	78.6	56.0
Incl. Emer. Facs....	52.0	62.3	19.2	58.5	78.6	59.3

About The Author

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of poor possibility into a highly profitable or attractive investment opportunity. Future competition is always a consideration, and early payouts (after tax consideration) more often than not are one requirement. On the other hand, the long range earnings forecast for any project is a must.

Long Range Predictions. There have been a number of articles published that treat the matter of long term advantages and disadvantages of accelerated depreciation. For example, see references 9, 4, and 10. Both Brown[4] and Edmonds,[9] in separate articles, show that tax deferment is permanent when companies change to accelerated methods of depreciation. They show that this holds in a growth company where capital investment is made at a constant or increasing rate. The deferment appears to be in proportion to the continued rate of capital investment. At the existing tax rates, the effect is said to be about 5 percent of the existing yields.

With the advent of nuclear energy and atomic chemistry, and the current tempo of new developments in a number of fields, the matter of obsolescence will become increasingly important. A major oil company reports that, by the use of atomic radiation, oil has been converted to gasoline and the technology of oil refineries might become obsolete. Obsolescence might eventually even overshadow the continuing problem of what to do about the decreasing purchasing power of the dollar. Obsolescence is one factor that presently precludes building adequate depreciation reserves and calls for faster write-offs. Technological advances, it is felt, might eventually bring matters in line, if the value of the dollar were stabilized, and tax rates kept in line. In any event, this is an era where the cost engineer's services will be of increasing importance.

The internal cash-generating ability represented by net profit after taxes and depreciation is certainly a prime measure of the attractiveness of an investment. The "Econograph," previously referred to, gives a visual concept of depreciation's role in affecting a project's attractiveness. Both return and payout indexes may be read for any depreciation condition. The return after payout is equally discernible. With the continuance of high level of capital outlays, and the growth in size of business firms, there is a growing need for engineers to recognize their responsibility, not only for projecting well designed operating plants, but for making the right economic choice.

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TABLE 5

Chemical Company Comparisons*

1956 Sales/Year	Deprec. D	Profit Pn	Tax t%	Pn+D	D/Pn	Plant C	Payout $Y=\frac{C}{Pn+D}$
Over $400 Million							
Allied Chem.	50.4	47.0	41	97.4	1.07	817	8.4
Amer. Cyanamid	30.1	44.2	48	74.3	.68	386	5.2
Dow (Fis. 1956)	76.6	55.9	47	132.5	1.37	686	5.2
duPont-Chem. Oper.	115.2	254.8	48	370.0	.45	1430	3.9
Eastman Kodak	35.9	94.2	53	130.1	.38	520	4.0
Monsanto	38.4	38.6	44	77.0	.99	517	6.7
Olin Mathieson	21.6	44.8	43	66.4	.48	480	7.2
Union Carbide	113.9	146.2	50	260.1	.78	1380	5.3
Over $100 Million							
Air Reduction	10.0	15.7	51	25.7	.64	158.6	6.2
Diamond Alkali	9.9	10.4	53	20.3	.95	133.0	6.5
Food Machinery	10.9	15.9	50	26.8	.68	161.2	6.0
Hercules	13.1	17.7	54	30.8	.74	153.0	5.0
Hooker'	7.2	11.5	50	18.7	.62	111.0	6.0
Koppers	11.9	12.1	50	24.0	.98	153.0	6.4
Rohm & Haas	9.2	16.1	54	25.3	.57	90.8	3.6
Stauffer	10.8	13.7	48	24.5	.79	98.9	4.0
Under $100 Million							
Amer. Potash	3.9	5.1	32	9.0	.76	55.6	6.2
Atlas Powder	2.5	4.2	53	6.7	.59	34.1	5.1
Comm. Solvents	3.2	2.8	51	6.0	1.14	70.2	11.7
Heyden (ex Newport)	1.5	1.5	43	3.0	1.00	23.4	7.8
Pennsalt	5.8	3.6	50	9.4	1.61	77.5	8.2
Spencer (Fis. 1956)	4.4	5.9	52	10.3	.74	58.0	5.6
Victor	3.4	3.7	48	7.1	.92	40.0	5.6
Wyandotte	5.2	5.0	40	10.2	1.04	106.2	10.4
Drug Companies							
Abbott Labs	2.1	10.9	48	13.0	.193	43.5	3.3
Am. Home Prods	2.8	31.3	53	34.1	.089	45.7	1.3
Eli Lilly	7.8	30.1	52	37.9	.259	90.8	2.4
Merck & Co.	7.5	20.2	51	27.7	.371	99.0	2.7
Parke, Davis	3.2	17.6	50	20.8	.182	61.0	2.9
Pfizer	5.7	18.3	44	24.0	.312	72.5	3.0
Schering	0.8	10.6	53	11.4	.075	9.16	0.8
Searle	0.5	6.6	52	7.1	.076	8.12	1.1

* Data for D, Pn, t, and C taken or derived from report WW 75-57 of White, Weld & Co.

KEY: D=Depreciation ($(000,000)
Pn=Net Profit (after taxes) $(000,000)
t=Tax Rate
Pn+D=Net Profit Plus Depreciation ($000,000)
D/Pn=Ratio of Depreciation to Pn
C=Gross Plant (Before depreciation) $(000,000)
Y=Payout (years)

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NOMENCLATURE

C = undepreciated cost of a physical asset or invested capital
C_e = salvage value at time y_e, dollars
C_o = initial investment, dollars
$\overline{C}$ = undepreciated value of a physical asset
D = depreciation, dollars per year
d = differential
E = overhead expense
I = interest on principal
k = constant in equations for depreciation
l_n = natural logarithm
p = fractional increase or decrease, with time, in price of an asset
P_n = net profit after taxes
S = cost of sales before key raw material cost
t = tax rate (expressed as a decimal)
x = fraction of unrecovered cost expressed as decimal
$X = 1 - x$
x_p y_p = dollar sales
x_k y_k = raw material cost
y_o = start of life for the new physical asset
y_e = useful life of physical asset, years
y = time of depreciation in years or other consistent unit, such as semi-annual, month, etc.
Y = payout time, years = the time when the sum of accumulated net profit and accumulated depreciation equals investment

$Y = \frac{C}{P_n + D}$. In economic depreciation $= \frac{\overline{C}}{P_n + D}$ where P_n and D reflect changing value of the dollar

Abbreviations for different depreciation methods:
DB — Declining Balance; SL — Straight Line
SD — Sum of Digits; SP — Sum of Percentages

Thermo Data for Petrochemicals

Part XXIII: Four-point Lagrangian interpolation coefficients make easy the calculation of the thermodynamic data for intermediate pressures from values given in the literature. The intervals need not be regular.

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RECENTLY a number of sources of thermodynamic data have become available in which the values are given at various pressures over a considerable range of temperature.[1,2,3] It is anticipated that in the future there will be other publications appearing which will give data for many more gases.

Most data have been for the gas behaving ideally, that is, at zero pressure, so the functions given have been $C_p°$, $H° - H_o°$, $S°$, $(G° - H_o°)/T$, where the degree sign represents the function for the gas behaving ideally.

"The National Bureau of Standards-National Advisory Committee for Aeronautics (N.B.S.-N.A.C.A.) Tables of Thermal Properties of Gases"[4] have been appearing as a series of sheets since 1949. This series has now been discontinued. Data for air, argon, carbon dioxide, carbon monoxide, nitrogen, oxygen, and steam have appeared in National Bureau of Standards Circular 564.[2] Data for nitrogen and for steam have been reviewed and tabulated in recent N.A.C.A. Technical Notes.[1,3]

These recent publications contain data for a number of pressures, rather than merely the ideal gas, or zero pressure values. These pressures are 0.1, 0.4, 0.7, 1.0, 4, 7, 10, 40, 70, and 100 atmospheres. These pressures can be grouped into three groups of four values each: 0.1, 0.4, 0.7, 1.0; 1, 4, 7, 10; 10, 40, 70, 100. Using a four-point Lagrangian interpolation formula set up for the 10-40-70-100 series of numbers, the intermediate values can easily be calculated.

The Lagrangian interpolation formula[5] can be used when the intervals between values of the argument (pressure in this case) are irregular. This is a systematic way of writing a polynomial passing through any number of points (four in this case). The method is perfectly general and can be applied to any pair of variables. The general case will be written for compressibility, Z, at any pressure, P, in terms of known sets of values of the variables.

$$Z = Z_1\left[\frac{(P-P_2)(P-P_3)(P-P_4)}{(P_1-P_2)(P_1-P_3)(P_1-P_4)}\right] + Z_2\left[\frac{(P-P_1)(P-P_3)(P-P_4)}{(P_2-P_1)(P_2-P_3)(P_2-P_4)}\right] + Z_3\left[\frac{(P-P_1)(P-P_2)(P-P_4)}{(P_3-P_1)(P_3-P_2)(P_3-P_4)}\right] + Z_4\left[\frac{(P-P_1)(P-P_2)(P-P_3)}{(P_4-P_1)(P_4-P_2)(P_4-P_3)}\right] + R_4$$

The term R_4 is the remainder that has been disregarded as not affecting the result. It is a measure of the accuracy of the fit of the polynomial to the true function.

The general form of the Lagrangian equation is apparent. If it is reduced to the two-point formula by eliminating all values except Z_1 at P_1 and Z_2 at P_2, the formula becomes a linear interpolation between the two points.

Coefficients for the four-point interpolation formula are given in Table 1 for values of pressure at increments of 5 atmospheres. These coefficients could also be used between 1.0 and 10 atmospheres, where they would represent an increment of 0.5 atmosphere. However, the variation of most of the functions with pressure is not sufficiently large to justify the use of a four-point formula, so that linear interpolation (two-point formula) can be used with sufficient accuracy.

Is it worthwhile to use the four-point formula? That depends on the accuracy with which you desire the results. Values calculated by linear interpolation may be sufficiently accurate for your purpose. What may be sufficiently accurate for one gas and one function may not be sufficiently accurate for another gas or another function. Table 2 lists the approximate maximum percentage deviations between values calculated by the four-point formula and by linear interpolation. For the compressibility factor, Z, for air the maximum deviation is about 1.1 percent at 85 atmospheres and 180 K.; however, for carbon dioxide at 85 atmospheres and 320 K.

the deviation is 2.8 percent. For carbon dioxide, the most "non-ideal" of the listed gases under ordinary conditions, the percentage deviation becomes as high as 5.0 percent for the specific heat, C_p/R, and 12 percent for the specific heat ratio, C_p/C_v. For other gases the errors for these same functions may be relatively small.

Visual inspection of the tabulated values and their rate of change with pressure will give a rough indication of the error that might arise from the use of linear interpolation. The engineer also knows the accuracy with which he needs the values that he is calculating. It is only a waste of time to use a highly accurate interpolation method if the values so obtained are to be used for an approximate calculation.

Please make these corrections to previous parts of this series which appeared in indicated issues of PETROLEUM REFINER.

1. Part VIII (Jan., 1950, page 126) Table I, data for SO_2, spectroscopic data of Cross are from 298° to 1800° K.
2. Part X (March, 1950, page 160) Tables 11 and 12, change Main Heat Capacities to *Mean* Heat Capacities.
3. Part XV (April, 1951, page 124) Second equation in Equation 3 should read:
   $a_o\Sigma x/y^2 + a_1\Sigma x^2/y^2 + \ldots + a_m\Sigma x^{m+1}/y^2 = \Sigma x/y$
4. Part XVI (June, 1951, page 143) Table 2
   Value at 700° R. change (+1.080450) (400) to (+1.081068) (400)
   800° R. change (+0.023100) (700) to (+0.023111) (700)
5. Part XX (Aug., 1954, page 109) Table 1, free energy function should be given as $-\frac{(G^\circ - H_o^\circ)}{T}$
   See Pennington and Kobe, J. Am. Chem. Soc., **79**, 300-5 (1957) for latest data on acetone.
6. Part XXI (Nov., 1954, page 164) Table 14, free energy function should be given as $-\frac{G^\circ - H_o^\circ}{T}$

TABLE 1

Four-Point Lagrangian Interpolation Coefficients for Interpolating Data to Intermediate Values of Pressure

For Value at P atm.	By Value Multiply at 10 atm.	By Value Multiply at 40 atm.	By Value Multiply at 70 atm.	By Value Multiply at 100 atm
10	+1.000000	0.000000	0.000000	0.000000
15	+0.721450	+0.432870	−0.196759	+0.042438
20	+0.493827	+0.740740	−0.296296	+0.061728
25	+0.312500	+0.937500	−0.312500	+0.062500
30	+0.172839	+1.037037	−0.259259	+0.049383
35	+0.070216	+1.053241	−0.150463	+0.027006
40	0.000000	+1.000000	0.000000	0.000000
45	−0.042438	+0.891204	+0.178241	−0.027006
50	−0.061728	+0.740741	+0.370370	−0.049383
55	−0.062500	+0.562500	+0.562500	−0.062500
60	−0.049383	+0.370370	+0.740741	−0.061728
65	−0.027006	+0.178241	+0.891204	−0.042438
70	0.000000	0.000000	+1.000000	0.000000
75	+0.027057	−0.150727	+1.053282	+0.070387
80	+0.049346	−0.259092	+1.037148	+0.172599
85	+0.062500	−0.312500	+0.937500	+0.312500
90	+0.061710	−0.296185	+0.740241	+0.494235
95	+0.042498	−0.197051	+0.433606	+0.720946
100	0.000000	0.000000	0.000000	+1.000000

TABLE 2

Approximate Maximum Percentage Deviation Between Four-Point Lagrangian and Linear Interpolation for Data in N.B.S. Circ. 564

Function / Gas	Compressibility Factor Z	Density ρ/ρ_o	Specific Heat C_p/R	Enthalpy $(H\text{-}E^\circ_o)/RT_o$	Entropy S/R	Specific Heat Ratio C_p/C_v	Velocity of Sound a/a_o
Air.....	1.1 85 atm. 180 °K	0.16 55 atm. 700 °K	1.8 5.5 atm. 3000 °K	0.7 2.5 atm. 3000 °K	0.2 5.5 atm. 3000 °K	0.2 55 atm. 3000 °K	0.4 55 atm. 200 °K
Argon..	0.8 85 atm. 180 °K	1.4 85 atm. 200 °K	0.01 0.55 atm. 100 °K	0.04 55 atm. 300 °K	0.9 25 atm. 300 °K	0.1 8.5 atm. 180 °K	0 85 atm. 180 °K
CO_2....	2.8 85 atm. 320 °K	10 85 atm. 320 °K	5.0 85 atm. 320 °K	0.2 25 atm. 350 °K	0.6 25 atm. 340 °K	12 85 atm. 320 °K	C.8 55 atm. 320° K
CO....	0.08 55 atm. 280 °K	0.07 85 atm. 280 °K	0.08 55 atm. 280 °K	0.2 25 atm. 300 °K	0.7 25 atm. 200 °K	0.01 85 atm. 280 °K	0.2 85 atm. 290 °K
H_2.....	1.1 85 atm. 50 °K	0.9 55 atm. 60 °K	.....	.....	.....	.....	.....
N_2.....	0.2 55 atm. 200 °K	2.2 25 atm. 200 °K	0.3 55 atm. 200 °K	0.04 25 atm. 200 °K	0.8 25 atm. 200 °K	0.4 55 atm. 200 °K	0.1 55 atm. 250 °K
O_2.....	0.2 85 atm. 200 °K	3.5 25 atm. 200 °K	0.07 85 atm. 250 °K	0.2 25 atm. 200 °K	0.7 25 atm. 200 °K	0.7 85 atm. 220 °K	0.6 85 atm. 220 °K

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[3] Woolley, H. W., Thermodynamic Properties of Gaseous Nitrogen. U. S. National Advisory Committee for Aeronautics Tech. Note 3271 (1956).

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[5] Works Projects Adm., Tables of Lagrangian Interpolation Coefficients, Columbia Univ. Press, New York, 1944.

About the Authors

Kenneth A. Kobe

Like father, like son aptly describes the combination that teamed up to write this article. **Donald H. Kobe**, son of the well-known and frequent Petroleum Refiner author, **Kenneth A. Kobe**, received his B.S. degree in chemical engineering from The University of Texas in 1956 and is now studying towards an M.S. degree at the University of Minnesota. He gained industrial experience during the summer months with the U. S. Forest Service in Oregon and Montana, and at Stanolind Oil and Gas Company in its Elk Basin, Wyo., field where he worked in field and plant operations. He has also worked in plant engineering for Standard Oil Company of California at Richmond, and at General Electric's Atomic energy plant in Washington.

Kenneth A. Kobe is a graduate professor of engineering at The University of Texas. He is an alumnus of the University of Minnesota, and has taught at Minnesota and Washington Universities. He has been at Texas since 1941.

Donald H. Kobe

Which CO_2 Removal Scheme Is Best?

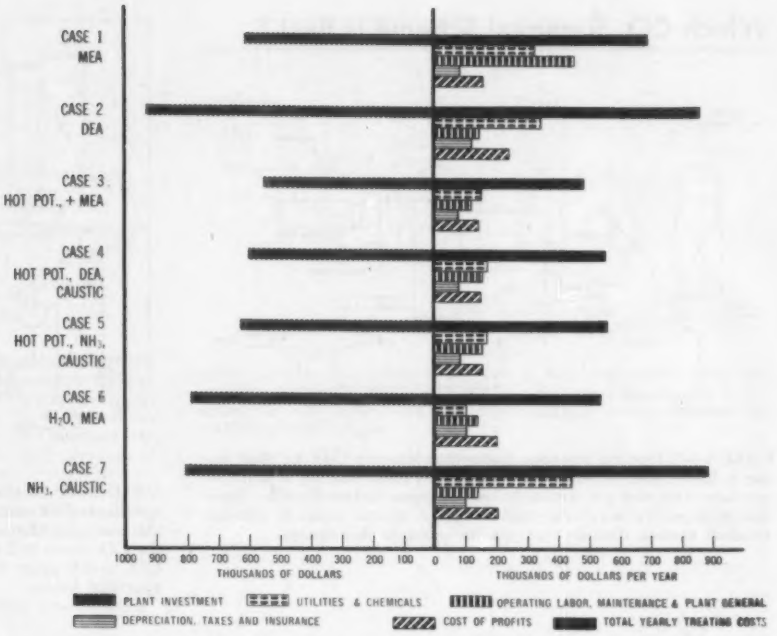


FIGURE 1—Over all cost comparison for the seven different CO_2 removal processing schemes.

Here is an economic comparison of seven different processing schemes for removing carbon dioxide from gas streams.

J. F. Mullowney,
The Fluor Corporation, Ltd., Los Angeles

A COMPARISON of the battery limits investment and operating costs for treating a gas stream containing about 34 percent carbon dioxide down to 10-25 ppm (by volume) by seven different treating schemes is presented.

Such a gas stream would be found in a plant manufacturing ammonia from natural gas by the use of a partial oxidation burner, or it might be encountered as a natural gas. In any case, the results of the study are believed to be valid for high CO_2 bearing gases over a considerable range on either side of the 34 percent CO_2 content arbitrarily picked for the study. To obtain a comprehensive picture of the investment requirements and operating costs for various process schemes, seven different treating schemes were studied:

- Case 1. Aqueous Monoethanolamine
- Case 2. Aqueous Diethanolamine followed by Caustic Treating
- Case 3. Hot Potassium Carbonate followed by Aqueous Monoethanolamine
- Case 4. Hot Potassium Carbonate followed by Aqueous Diethanolamine then Caustic Scrubbing
- Case 5. Hot Potassium Carbonate followed by Aqueous Ammonia Treating and Caustic Scrubbing
- Case 6. Water Scrubbing followed by Aqueous Monoethanolamine
- Case 7. Aqueous Ammonia followed by Caustic Scrubbing

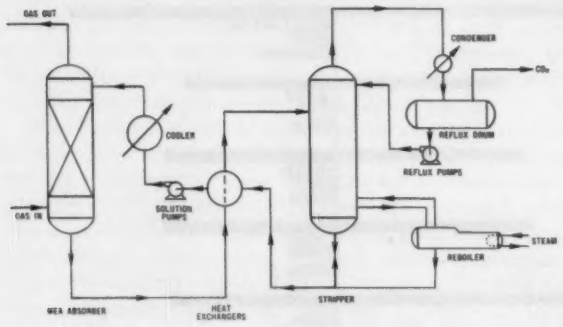
Many other treating schemes might have been used, but these processes are commonly used to remove carbon dioxide from gases containing high percentages of CO_2 down to the low limits established.

The manner in which the plant investment and operating costs, both direct and indirect, were developed for this evaluation are discussed. The comparative yearly costs for removing carbon dioxide, as well as the advantages and disadvantages of the various treating schemes, are also presented and discussed.

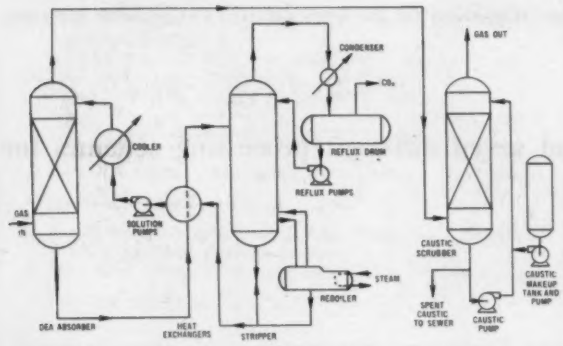
Process Schemes and Design Considerations. To obtain realistic investment costs for a typical plant and location, complete process calculations were made for each case and all major equipment such as absorbers, strippers, heat exchangers, accumulators, knockout pots, pumps, storage facilities, etc., were sized. An experience factor was applied to the total equipment cost to obtain the approximate installed investment required for each scheme.

For this study, a gas flow of 12 million standard cubic feet per day was selected (which would be roughly equivalent to a 100 ton per day ammonia plant gas stream). This gas has 34.3 weight percent carbon dioxide and a molecular weight of approximately 17.

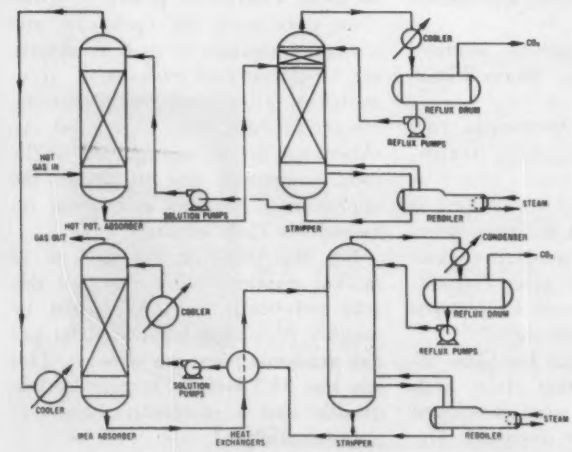
Which CO_2 Removal Scheme is Best?



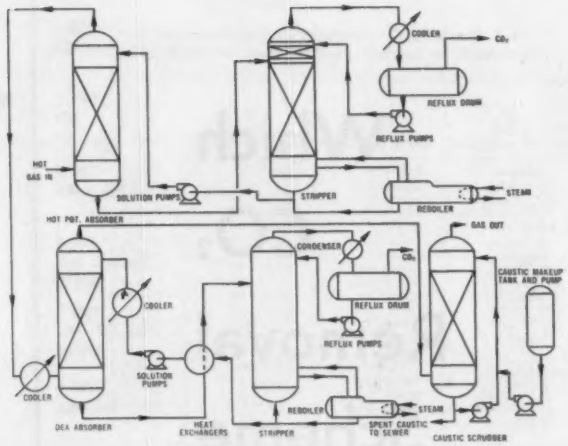
CASE 1—A typeical aqueous monoethanolamine (MEA) plant using a 15-20 percent solution. The design basis was for a plant to produce a treated gas stream below 10 ppm carbon dioxide. Since this high purity is reliable and steady, a caustic plant to remove residual carbon dioxide was not included in this design.



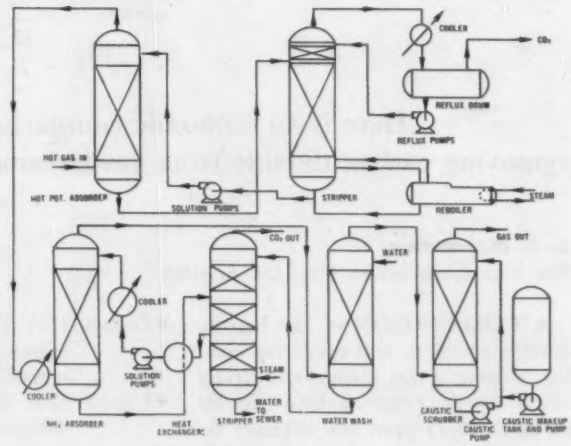
CASE 2—Aqueous diethanolamine (20-25 percent solution) followed by a caustic scrubbing unit. Gas from the amine unit contains approximately 200 ppm carbon dioxide and caustic scrubbing reduces it to the desired 10-25 ppm range. Although CO_2 residual is lower than typical DEA plant practice, it is quite easily attainable with proper allowances in design.



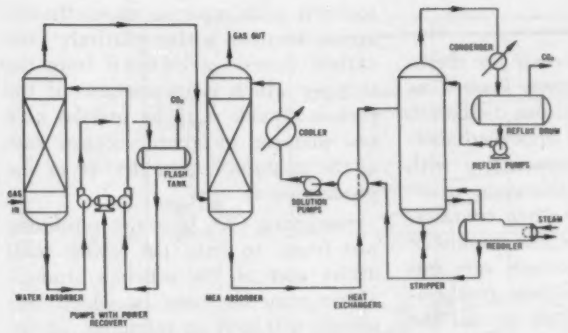
CASE 3 (left)—In the hot potassium carbonate followed by aqueous monoethanolamine case, gas at about 280 F is treated first with hot carbonate solution to remove the bulk of the CO_2, and then cooled to 100 F for MEA treating to reduce CO_2 to less than 25 ppm. Carbon dioxide content is reduced to 2 percent by countercurrent extraction with hot 30-40 weight percent K_2CO_3 solution. The hot carbonate system does not require heat exchange usually found in other treating schemes. Treating the hot gases results in heat exchange savings due to the high temperature level and because of the removal of about 95 percent of the carbon dioxide, saving cooling costs for the CO_2.



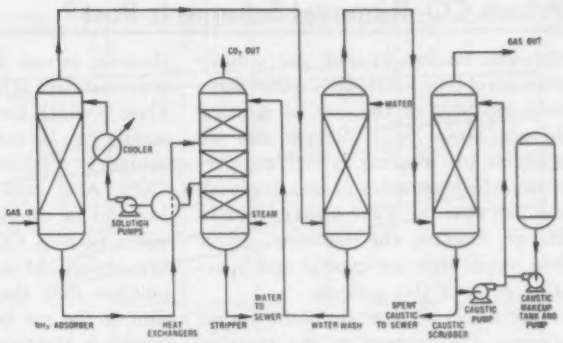
CASE 4—Uses three different processes to obtain the gas purity specified: Hot potassium carbonate, followed by aqueous diethanolamine and then caustic scrubing. Hot carbonate first removes the CO_2 down to 2 percent as in Case 3; next, aqueous DEA reduces CO_2 to 200 ppm; then, caustic is used to produce a gas within the epecified limits.



CASE 5—As in Case 4, the gas is first contacted with hot potassium carbonate reducing the CO_2 to 2 percent. An aqueous ammonia solution is then used to reduce the CO_2 to 150 ppm and is followed by caustic scrubbing to reduce CO_2 to 12-25 ppm. The new process introduced in this case is scrubbing with an aqueous ammonia solution (about 2-5 percent ammonia). The rich or outlet solution from the contactor flows through heat exchange to a stripper which removes the CO_2 from the solution by stripping with steam.



CASE 6—Water followed by aqueous monoethanolamine treating. Water contacts the gas in a typical packed absorption column and removes CO_2 down to 2 percent. Water containing CO_2 is flashed at near atmospheric pressure to release the CO_2 and recirculated back to the contactor. Low solubility of CO_2 in water requires high water circulation rates and hence a large amount of pumping energy. About 60 percent of this energy is recovered by a turbine driven by water from the bottom of the absorber. No exchangers or regeneration heating is required for this part of the process. MEA scrubbing is used to reduce the CO_2 content to 10-25 ppm using the process in Case 1.



CASE 7—In this scheme the gas is first contracted with an aqueous ammonia solution as in Case 5. Here CO_2 content is reduced to 150 ppm with the final cleanup being effected by scrubbing with caustic.

Table 1—UTILITY, DIRECT AND INDIRECT OPERATING COSTS:

1. Steam @	$0.55/1000 lbs.
2. Electricity @	$0.01/kw/h
3. Cooling water @	$0.02/1000 gals.
4. Process water @	$0.10/1000 gals.
5. Gas losses @	$0.50/1000 standard cu. ft.
6. Chemical losses @	Current 1957 prices

DIRECT OPERATING COSTS:

1. Operating labor	Foreman, $3.50 per hour; operators, $2.75 per hour; plus 22 percent burden to cover vacation, insurance and other benefits.
2. Maintenance	Annually 4 percent of plant investment, typically 60 percent for labor and 40 percent material.
3. Plant general	Annually 40 percent of total direct labor cost, includes nonoperating services and personnel up to and including plant manager.
4. On stream time	360 days for all cases.

INDIRECT OPERATING COSTS:

1. Depreciation	Annually 10 percent of plant cost.
2. Taxes and insurance	Annually 2.5 percent of plant cost.

This gas was assumed to be available at a pressure of 350 psig and a temperature of 100 F. saturated with water, except that in the hot potassium carbonate scrubbing cases the gas was available at 280 F. and saturated.

To establish comparative capital costs, all equipment was sized using the same basis. For instance, the same temperature approach was used for exchangers of similar types in the various processes. Consideration was also given for special alloys required in exchangers in especially corrosive services. Conventional and established good design practices were followed throughout in the selection and sizing of all of the equipment.

The utility costs shown in Table 1 were selected as being typical. They include payoff of the capital investment, as well as the normal operating costs of the facilities required to provide these services.

The yearly cost referred to as "cost of profit" is about 25 percent of the original plant investment. This factor is used in the chemical and petroleum field to provide a reasonable plant payout and profits after income taxes.

Investments and Costs. The plant investments as well as the operating costs, both direct and indirect, are shown in Table 2. The last item in the Table is a comparison of the costs required to treat 1000 SCF of gas to the purity required. On the basis of the cost figures cited above, Case 3 (hot potassium carbonate followed by aqueous monoethanolamine) has the lowest treating cost of the schemes studied, $0.01/1000 SCF. Case 6, in which water scrubbing was followed by monoethanolamine treating, was only $1.01/1000 SCF more.

The highest cost in this study was $0.19/1000 SCF for Case 7 using aqueous ammonia followed by caustic. This method of treating is usually employed at lower concentrations of carbon dioxide, and has certain advantages over other schemes when various contaminants are present in the gas.

Inspection of Table 2 indicates that the steam costs generally predominate the utility costs and determine, to a large extent, the differences found in the utility costs. Note that the steam costs are from 58 to 87 percent of the utility costs with the exception of Case 7 (water scrubbing followed by aqueous monoethanolamine) which was only about 10 percent. In this Case, steam was used only in the final cleanup with aqueous monoethanolamine as no heat was required in the water wash unit. In all cases, steam was used only for regenerating the solution as all pump drivers were electric. It can also be seen that the utility costs vary from approximately 30 percent to 50 percent of the total operating cost, again with the exception of Case 7 which was found to be about 20 percent. It is obvious, therefore, that the utility costs are of great importance in the selection of a process scheme.

Figure 1 presents a comparison of all cases used in this study. The total plant investment costs are shown on the left side. The direct and indirect costs, as well as the total yearly operating costs, are shown on the right side.

Influencing Factors. It is clear that there may be factors other than economics which influence the choice of processing scheme. For instance, we have assumed the gas to be available at 280 F. for hot potassium carbonate scrubbing. In this study a savings was found for this process because of the smaller gas cooler and lower cooling water requirements for cooling the gas down to 100 F. This, of course,

was due to the smaller gas volume after scrubbing, and the savings have been included in the cost of treating the gas. However, if the gas was not available for treating at high temperatures, the economics of treating with hot potassium carbonate would change. Cooling the gas after scrubbing would increase capital and operating costs of this process.

The effect of contaminants found in some gas streams on the treating solution has to be considered when selecting a process to remove carbon dioxide. If COS, CS_2, etc., are present in the gas and not completely removed by the carbonate solution, they will combine with monoethanolamine to form nonregenerable compounds which will not pick up carbon dioxide, as well as increase the chemical costs of this process. Case 2 or Case 4 which uses aqueous diethanolamine, can be utilized since diethanolamine is relatively nonreactive with COS. Also aqueous ammonia treating can be employed when contaminants such as COS or like impurities are present. It is, therefore, very important that the complete composition of the gas be known so that the optimum treating soultion can be selected.

Other factors which might indicate a different scheme from those included in this study might be mentioned. For instance, if dehydration as well as CO_2 removal was required, treating with a glycol-amine solution may result in a substantial savings of both the initial plant investment and operating costs when including the dehydration step in the cases studied. As in treating with aqueous monoethanolamine, the CO_2 can be reduced to 10-25 ppm without caustic scrubbing by proper design methods.

Aqueous monoethanolamine treating is usually the preferred process because of its simplicity, as well as other advantages. The plant cost was found to be only slightly higher than the lower priced schemes studied. For gases containing lower concentrations of CO_2, the economic advantage found in some of the other schemes may equalize or even reverse if the carbon dioxide is to be reduced to less than 25 ppm. An advantage associated with aqueous monoethanolamine treating is the relatively pure carbon dioxide produced from the stripper which is important if the carbon dioxide is to be utilized as a raw material in other processes such as the manufacture of dry ice or the production of urea.

Removing CO_2 by water scrubbing was found to have the lowest total utility cost of the schemes studied. There may be cases in which this scheme will have an economic advantage, especially if the gas is available at high pressures and the gas losses due to its solubility in water can be tolerated.

Conclusions. The most economical process scheme was found to be hot potassium carbonate followed by aqueous monoethanolamine ($0.11/1000 SCF). However, the cost by this method was only slightly lower than three of the other schemes studied. The selection of this process can be modified by a change in the basic assumptions, such as costs or condition of the gas, made in this study.

Two factors primarily determining the total operating costs were:

1. The steam costs.
2. The plant investment.

Utility costs were found to be directly related to the amount of steam required for each scheme as only minor differences were established by other utilities. The plant investment, on the other hand, determines the other operating costs such as maintenance, depreciation, insurance and taxes.

About the Author

James F. Mullowney, a process chemical engineer with The Fluor Corp., Ltd., joined that firm in 1950 as a research chemical engineer. He obtained his B.S. degree in chemical engineering from the University of Nebraska in 1949. Before joining Fluor he was associated with Exchange Orange Products Co., Ontario, California.

TABLE 2—Plant Investment and Operating Costs

CASE	1	2	3	4	5	6	7
PLANT INVESTMENT	$607,000	$921,000	$545,000	$596,000	$619,000	$778,000	$793,000
Direct Operating Costs $/Year:							
Utilities $/Year:							
Steam @ $0.55/1000 lbs.	262,000	252,000	93,000	97,000	96,000	10,000	366,000
Electricity @ $0.01/KWH	19,000	29,000	19,000	18,000	21,000	41,000	19,000
Cooling water @ $0.02/1000 gal	32,000	32,000	18,000	18,000	19,000	7,000	33,000
Process water @ $0.10/1000 gal	.....	.....	.....	.....	1,000	.....	11,000
Gas losses @ $0.50/1000 SCF	4,000	3,000	7,000	8,000	5,000	37,000	3,000
Chemical losses @ cost	2,000	17,000	11,000	26,000	26,000	2,000	3,000
Subtotal	319,000	333,000	148,000	167,000	168,000	97,000	435,000
Operating labor	47,000	47,000	47,000	66,000	66,000	47,000	47,000
Maintenance @ 4 percent plant cost	24,000	37,000	22,000	24,000	25,000	31,000	32,000
Plant general	21,000	23,000	20,000	26,000	27,000	22,000	22,000
Subtotal	92,000	107,000	89,000	116,000	118,000	100,000	101,000
Total Direct Costs	411,000	440,000	237,000	283,000	286,000	197,000	536,000
Indirect Operating Cost $/Year:							
Depreciation @ 10 percent of plant cost	61,000	92,000	55,000	60,000	62,000	78,000	79,000
Taxes and insurance	15,000	23,000	14,000	15,000	15,000	19,000	20,000
Total Indirect Costs	76,000	115,000	69,000	75,000	77,000	97,000	99,000
Total of operating costs	487,000	555,000	306,000	358,000	363,000	294,000	635,000
Cost of profit (before income tax) @ 25 percent of plant cost $/year	152,000	230,000	136,000	149,000	155,000	195,000	198,000
Grand total treating cost $/year	$639,000	$785,000	$442,000	$507,000	$518,000	$489,000	$833,000
Treating Cost—Dollars per Thousand SCF Gas Treated	$ 0.15	$ 0.19	$ 0.11	$ 0.12	$ 0.12	$ 0.12	$ 0.19

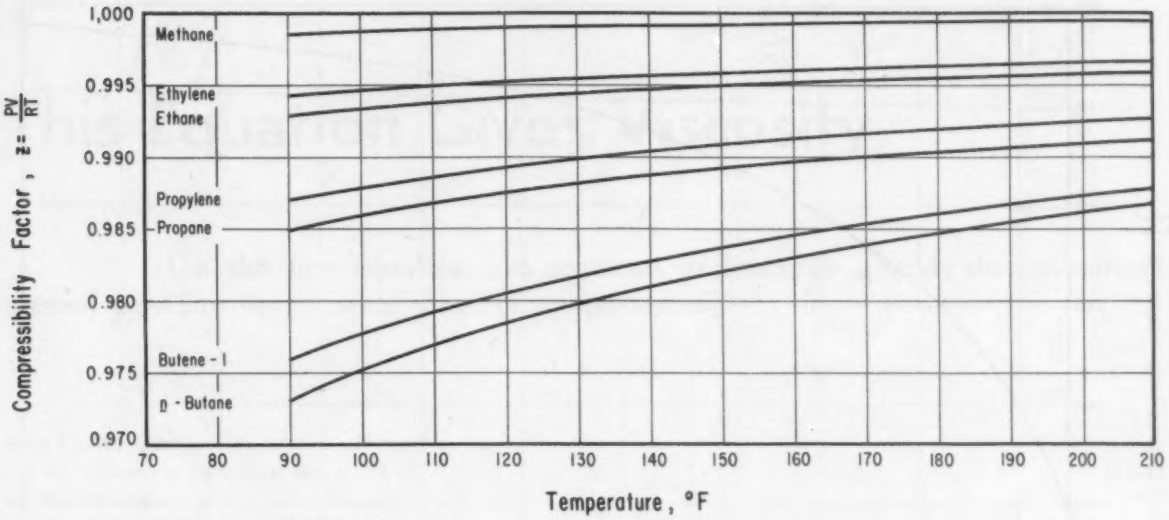


FIGURE 1—Compressibility factor vs. temperature for seven gases at one atmosphere pressure.

Generalized Z Chart for Low Pressures

This generalized compressibility chart gives results to within 0.10 percent of the actual values for the light hydrocarbons.

H. W. Pfennig* and John J. McKetta
Chemical Engineering Department
The University of Texas, Austin, Texas

USING THE DATA from two recent investigations[4,5] a generalized compressibility chart was prepared. The range of reduced pressures is from zero to 0.05. The range of the reduced temperature is from 0.75 to 1.9.

The PVT behavior of ethylene, propylene and butene-1 was reported by the authors[4] at 90°, 120°, and 150 F for a pressure range extending from 400 to 1500 mm of mercury. An Edwards-type gas density balance was used in the investigation and the compressibilities were believed to have been determined within 0.10 percent of the actual value.

The PVT behavior of methane, ethane, propane, and n-butane was studied by Silberberg, Kuo, and McKetta[5] over this same pressure and temperature range. An Edwards-type gas density balance was also used in their investigation with an overall accuracy with in 0.10 percent of the actual value.

The data from these two investigations were combined to construct a generalized reduced compressibility chart for methane, ethane, propane, n-butane, ethylene, propylene, and butene-1. Critical properties reported by Kobe and Lynn[3] were used in calculating the reduced values. This chart was made by first making a compressibility against temperature plot at a constant pressure of one atmosphere as shown in Figure 1. From this plot a reduced compressibility chart was made which was smoothed by plotting compressibility factors against reduced temperature at a constant reduced pressure 0.03 and drawing the best smooth curve through these points. The resulting smoothed chart as shown in Figure 2 is believed to be accurate to within 0.1 percent of the actual values.

The final reduced chart, Figure 3, was compared with other charts found in the literature. The chart prepared by Hougen and Watson[2] compares well with the values reported here at the lower reduced temperatures, but differs as much as 0.4 percent at higher values of reduced temperature. When comparing this work with that of Brown et. al.[1] it was found that the values of compressibility differed less than 0.05 percent at the higher values of reduced temperature but differed as much as 0.8 percent at the lower values of reduced temperature. All comparisons were made at a reduced pressure of 0.05.

* Mr. Pfennig is now with Merichem Company, Houston.

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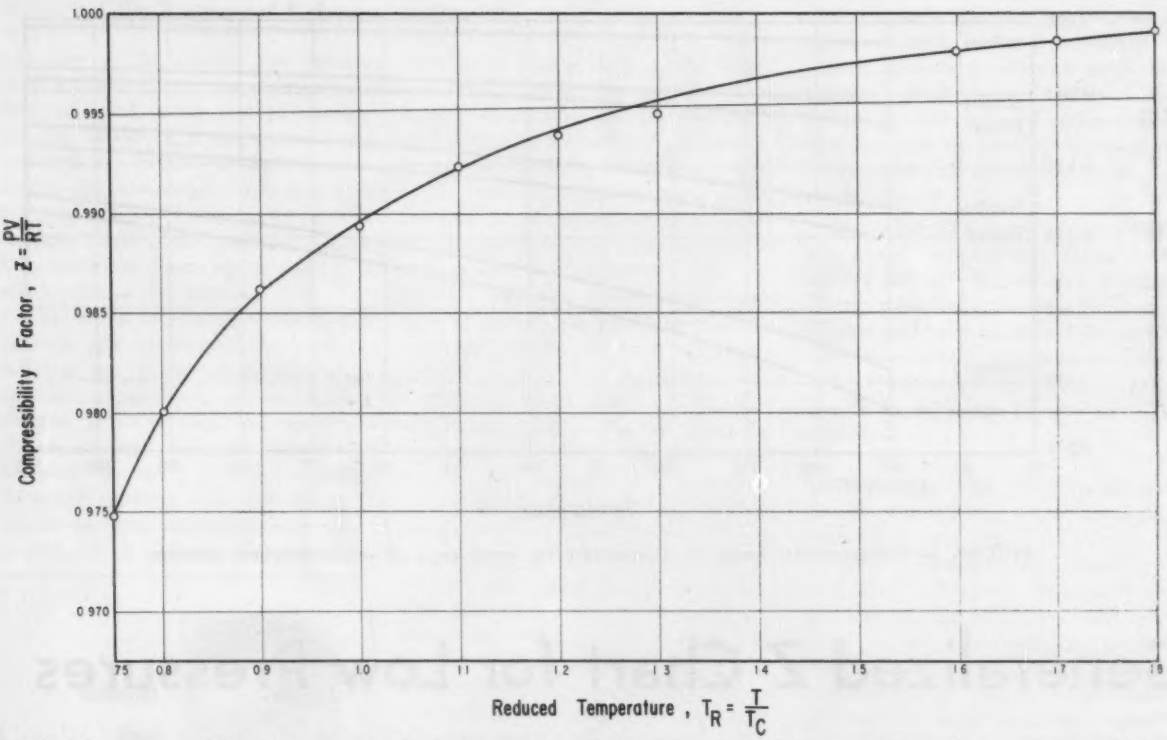

FIGURE 2—Compressibility factor vs. reduced temperature at reduced pressure of 0.03 for methane, ethane, propane, n-butane, ethylene, propylene and butene-1.

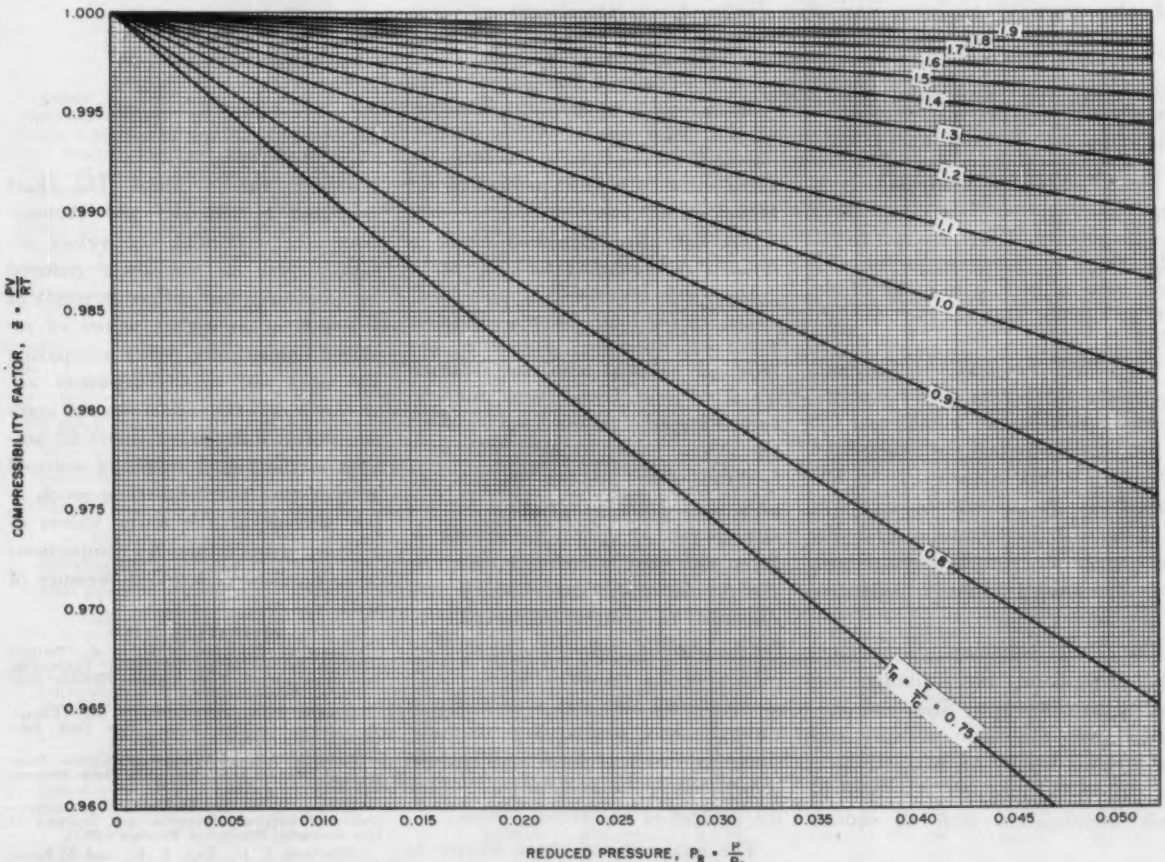

FIGURE 3—General reduced compressibility chart.

This Equation Gives Viscosity

Use this new equation and constants to determine quickly the viscosities of normal paraffins over a wide range of temperatures.

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VISCOSITY IS one of the most important physical properties of a fluid, and numerous equations have been proposed for the viscosity of liquids. A review[2] of the more important equations indicates that most of the equations have found only limited application for a few compounds and generally over only small temperature ranges.

The viscous flow of liquids can be interpreted as a rate process, and the basic rate equation is fairly accurate for representing the viscosity of liquids at their boiling point.

$$\mu = A_1 e^{B_1/T} \qquad (1)$$

When this equation is tested for viscosity data over a fairly large temperature range, the equation has usually been found to be relatively inaccurate.

Powell, Roseveare, and Eyring[6] suggested a modification of the basic rate equation (Equation 1).

$$\mu = \frac{hV}{N} e^{\Delta F_{vis}/RT} \qquad (2)$$

The term ΔF_{vis} was reported[6] to be related to the internal energy of vaporization by the following relationship:

$$r = \frac{\Delta E_{vap}}{\Delta F_{vis}} = 2.45 \qquad (3)$$

Albright and Lohrenz[1], however, demonstrated that r varies with temperature and, of course, must be zero at the critical temperature since the internal energy of vaporization is zero at that temperature.

Another proposed modification of Equation (1):

$$\mu = \frac{N}{V}(2\pi m k T)^{1/2} v_f^{1/3} \cdot \exp\left(\Delta E_{vap}/r' + PV/r''\right)/RT \qquad (4)$$

Albright and Lohrenz[1] also tested this equation for several paraffin hydrocarbons. The equation was difficult to apply because the term v_f was hard to evaluate. It was suggested[4] that the term be evaluated from sonic velocities in the liquid and the gas. The equation was found to be accurate within about 10 to 25 percent for the few cases in which sufficient data were available. Although the equation is promising when data become available, it will always be difficult to apply.

Innes[5] recently demonstrated that the following equation was applicable for liquid water, mercury, methyl alcohol, and n-heptane over large temperature ranges:

$$\mu = A T^n e^{B_2/T} \qquad (5)$$

The terms A, B_2 and n are constants for a given liquid. He found that the term n was equal to 1.0 for n-heptane.

Equation 5 can be converted to the following form if desired:

$$\mu = A T^n (10)^{B/T} \qquad (6)$$

When Equation (6) was tested for a large number of hydrocarbons it was found to fit all hydrocarbons tested and constants for the equation are given in the table and Figures 4 and 5.

Correlation Procedure. The viscosity of hydrocarbons has been tabulated by the American Petroleum Institute Project No. 44.[3] The data in general are reported over wide ranges of temperatures up to approximately the normal boiling point. Other data[1, 7, 8, 9] used in this study are for higher temperatures and pressures equal to approximately the vapor pressure.

By means of a trial and error method, it was determined that the term n is equal to 1.0 within the experimental accuracy of the data used. Equation (6) was rearranged and logarithms were taken to yield the following form:

$$\log_{10}\frac{\mu}{T} = \log_{10} A + B/T \qquad (7)$$

Plots were made of the $\log_{10} \mu/T$ versus 1/T. Such plots are shown in Figures 1, 2, and 3 for the lighter normal paraffins up to decane, the heavier paraffins from decane to eicosane, and miscellaneous hydrocarbons respectively. Straight lines represent the data within an accuracy of 7 percent and generally 2 percent.

Notice in the case of the normal paraffin hydrocarbons, from propane to heptane, that the data are represented for a given compound by two straight lines. One straight line is for the data at lower temperatures, while the second line with a steeper slope is for the data at higher temperatures. The intersection of the two straight

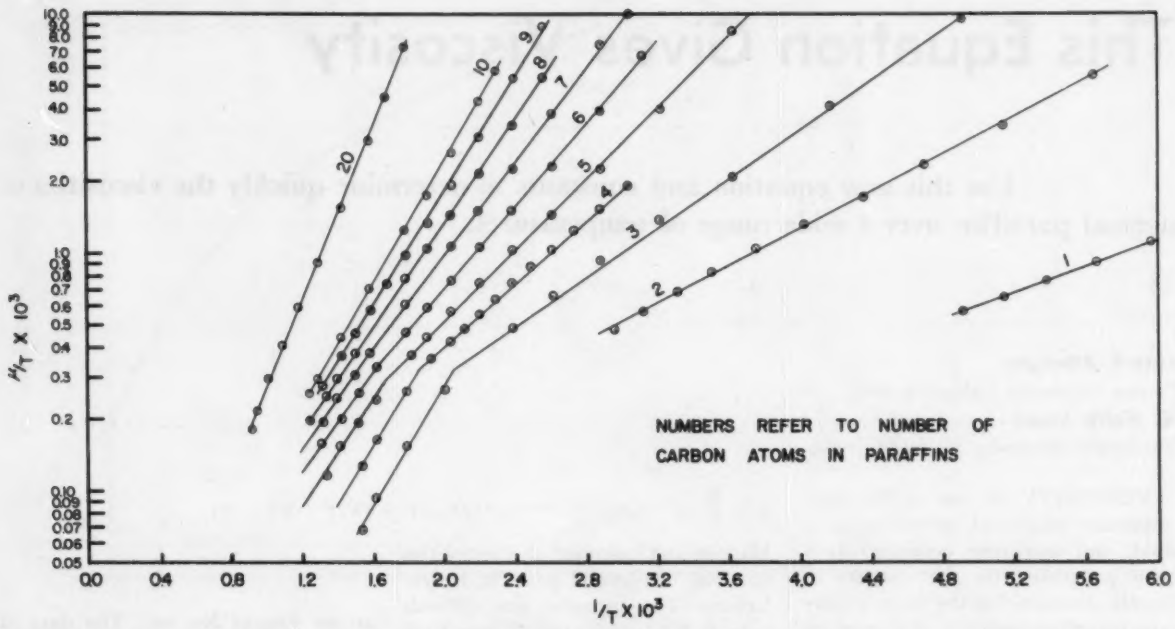

FIGURE 1—Viscosity correlation for light normal paraffins for Equation 7. The slope of the straight lines are equal to the term B in Equation 6 and the intercept equals $\log_{10} A$.

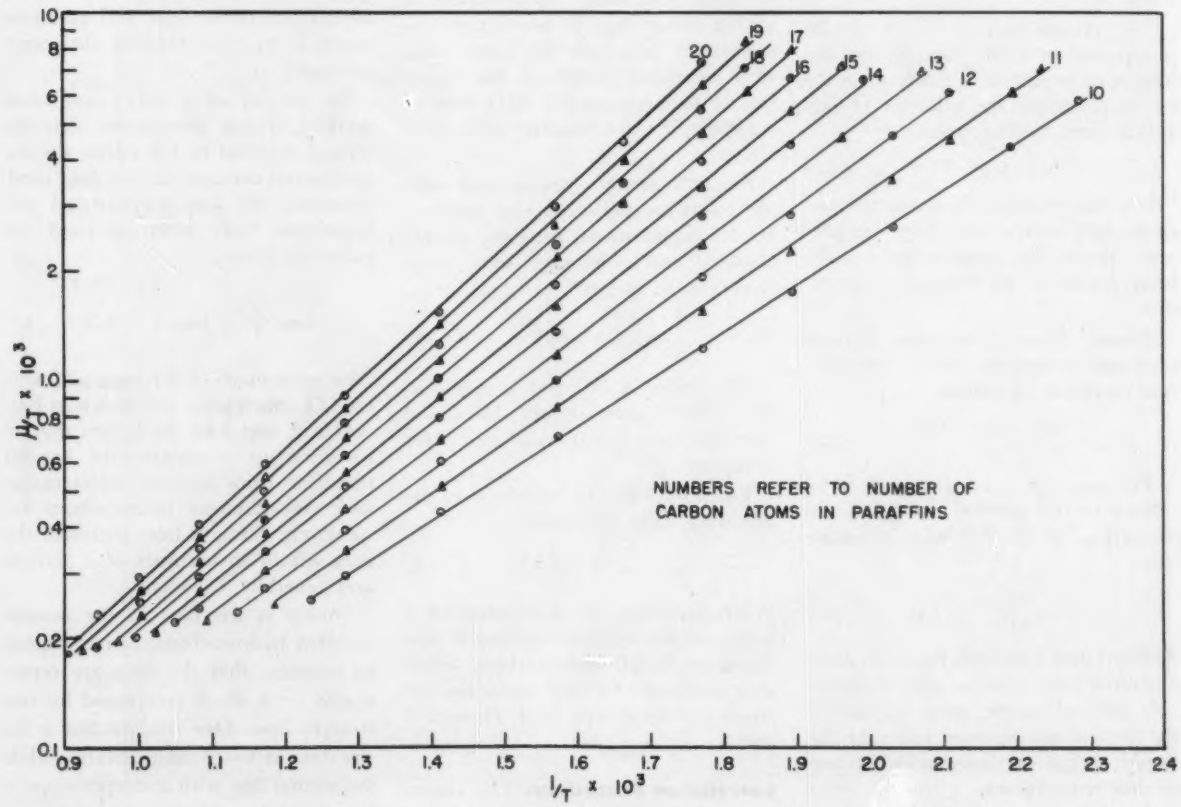

FIGURE 2—Viscosity correlation for heavy normal paraffins for Equation 7. Notice the absence of a break in the straight lines as compared to Figure 1.

lines occurs at a temperature close to the normal boiling point.

The slopes of the straight lines are equal to the term B in Equation (6) and the intercept equals $\log_{10}A$. Actually A and B were solved in this study by setting up two simultaneous equations of 7, and solving for the two constants. In the case of the paraffins from propane to heptane, two values of A and B were determined. The values of the constants are reported in Tables 1 and 2 for the normal paraffins and the miscellaneous hydrocarbons respectively.

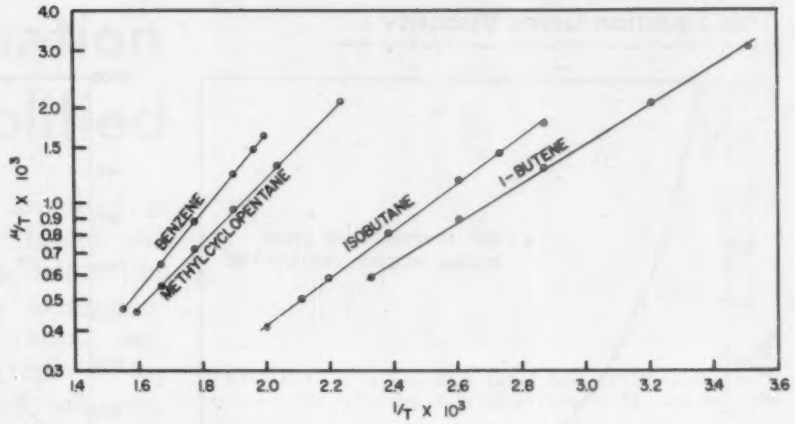

FIGURE 3—Viscosity correlation for miscellaneous hydrocarbons. Here again notice the straight lines.

Discussion of Results. The viscosity data reported in API Project No. 44 are for temperatures below the normal boiling points and are represented for a given compound by a single straight line. Although the data at higher temperatures appear to be less reliable, probably there is a real break in the viscosity plots as shown in Figure 1 for compounds such as propane, butane and other of the lighter paraffins. Fitting the data with two straight lines is rather arbitrary. A less convenient alternative would be to let the value of n of Equation (6) vary in the light paraffin series. Probably the breaks in the lines of Figure 1 can be attributed to pressure which seems to have a significant effect in the case of hydrocarbons.

The reliability of the present data can be checked to some extent by plotting both A and B versus the number of carbon atoms in the paraffin molecule, as was done in Figures 4 and 5 respectively. Two curves, of course, occur for both A and B in the cases of propane to heptane. Yet in all cases smooth curves closely represent the calculated values of A and B. The predicted values of A and B as determined from the curves in Figures 4 and 5 were tested in Equation (6). The predicted values of viscosity agreed in all cases with the values used in the original calculations within 10 percent and generally considerably less. These results tend to support the reliability of the viscosity data used for the normal paraffins.

The values of A and B for heptane at lower temperatures were found to agree well with the values reported by Innes.[5] In the present case it was decided to use both a high and a low temperature equation for heptane rather than a single equation as Innes did. A single equation is almost as accurate but since two equations were used for the paraffins from propane to hexane, it was decided to use two in the case of heptane in order to obtain slightly better accuracy.

The value of A for methane appears to be anomalous as compared to the values for the other light paraffins. As the first member of the series there is a good possibility its behavior is not comparable to that of the other paraffins, even though its B value plots in a correlatable manner. There is, of course, the possibility that the values of viscosity for methane are inaccurate, which would not be unexpected since its viscosity would be most difficult to measure because of the low temperatures (—256 F. and below) involved.

The relatively straight line relationship of B for the light paraffins as shown in Figure 5 is of interest. Apparently the addition of each carbon atom to the chain causes an approximately constant increase in B, which is related to the energy of activation for flow. It is further not surprising that the increase of B becomes smaller as the paraffin chain becomes longer. Probably the chain tend to "bend over" and "ball up" more with the longer paraffins, so each additional CH_2 group has less effect.

Equation (6) was also tested for miscellaneous hydrocarbons to determine if the equation applied to families of hydrocarbons other than paraffins. The available viscosity data are much more limited, especially over large temperature ranges, for the other type hydrocarbons. Equation (6) was found to correlate the data in an excellent manner for isobutane, 1-butene, benzene, and methylcyclopentane. It is highly probable that Equation (6) is applicable for other isoparaffins, olefins, aromatics, and cycloparaffins.

The A and B values reported in Tables 1 and 2 can probably be used to extrapolate the viscosity data of the liquid hydrocarbons to some extent. It is not recommended, however, that the temperatures be extrapolated much beyond the normal boiling point, since it was found that in case

TABLE 1
Values of A and B for Normal Paraffins

Normal Paraffin	A x 10^5	B
Methane	2.42	279
Ethane	3.55	389
Propane	2.82 (0.077)	517 (1280)
Butane	1.98 (0.155)	656 (1245)
Pentane	1.62 (0.388)	752 (1125)
Hexane	1.34 (0.596)	863 (1077)
Heptane	1.08 (0.79)	978 (1065)
Octane	0.861	1096
Nonane	0.728	1202
Decane	0.662	1283
Undecane	0.590	1373
Dodecane	0.553	1437
Tridecane	0.530	1498
Tetradecane	0.516	1549
Pentadecane	0.476	1612
Hexadecane	0.456	1666
Heptadecane	0.425	1721
Octadecane	0.416	1760
Nonadecane	0.430	1784
Eicosane	0.426	1820

* Values in parenthesis are values of A and B for viscosity data at temperatures higher than reported in API Project No. 44.
For propane above 30 F.
For butane above 80 F.
For pentane above 140 F.
For hexane above 160 F.
For heptane above 180 F.
If Equation 5 is used multiply B values by 2.3.
If temperature in degrees Kelvin are used in Equation 5, multiply A values by 1.8 and B values by 2.3/1.8.

TABLE 2
Values of A and B for Miscellaneous Hydrocarbons

Hydrocarbon	A x 10^5	B
Isobutane	1.33	743
1-Butene	2.21	614
Benzene	0.591	1223
Methylcyclopentane	1.083	1022

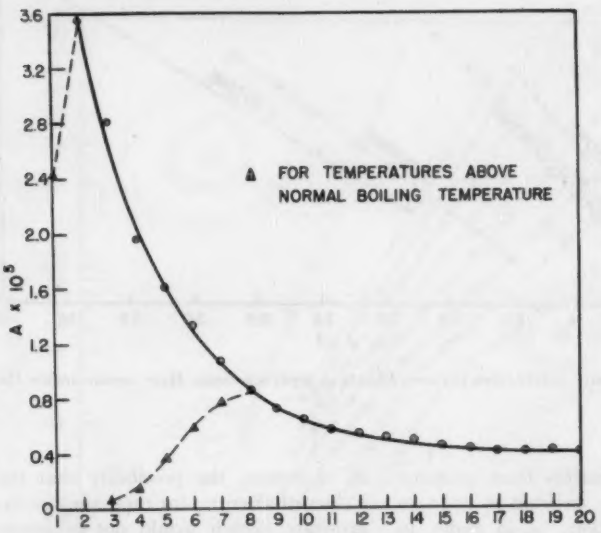

FIGURE 4—Value of A for normal paraffins plotted against the number of carbon atoms in the paraffin. Notice that there are two curves from propane to heptane.

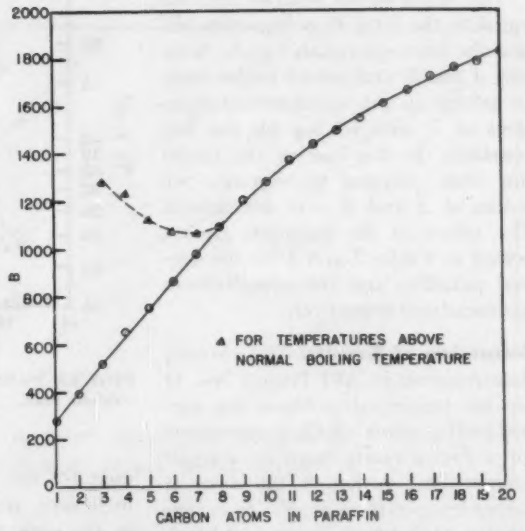

FIGURE 5—Values of B for normal paraffins plotted against the number of carbon atoms in the paraffin. Notice the straight lines from propane to heptane and that addition of each carbon atom causes less increase in B.

of the lighter hydrocarbons a distinct change of curvature occurred at the higher temperatures. The behavior at the higher temperatures should be further studied. It is especially probable that both ethane and methane exhibit breaks as propane and the other light paraffins do.

Innes[5] reported that in the cases of water and methanol, Equation (6) was quite inaccurate for predicting viscosities near the freezing points. These liquids are both polar so a comparison with the non-polar hydrocarbons may not be applicable. Innes, however, noted that the calculated viscosity values for n-heptane near the freezing point were slightly less accurate than those at higher temperatures. Extrapolations near the freezing points, therefore, should be considered relatively inaccurate until proven otherwise.

In certain cases it may be more convenient to use Equation (5) rather than Equation (6). In this case the values of *B* reported in Table 2 are multiplied by 2.3. The values of A as shown in the tables need not be altered. If Equation (5) is to be used with temperature in degrees Kelvin, then the A values of Table 1 must be multiplied by 1.8 and the *B* values must be multiplied by (2.3/1.8).

Summary. A modified rate equation has been found to correlate the available viscosity data of normal paraffins, benzene, isobutane, 1-butene, and methylcyclopentane over wide temperature ranges. Presumably the equation is applicable for other hydrocarbons in the aromatic, isoparaffin, olefin, and cycloparaffin families.

NOMENCLATURE

A, A_1, B, B_1, B_2—constants in Equations 1, 5, 6, and 7
h—Planck's constant
k—Boltzmann constant
m—reduced mass
n—constant for Equation 5 and 6
N—Avogadro's number
P—vapor pressure
r, r', and r"—energy ratios
R—gas constant
T—absolute temperature, °R
v_f—free volume
V—molar volume of saturated liquid
ΔE_{vap}—internal energy of vaporization
ΔF_{vis}—free energy of activation for flow
π—3.1416
μ—viscosity, centipoises

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Radial Deformation of Rings Simplified

Annular rings are used to transmit transverse forces and moments into a circular shell. The laborious energy method of calculating radial, ring deformation may be replaced by these simplified solutions.

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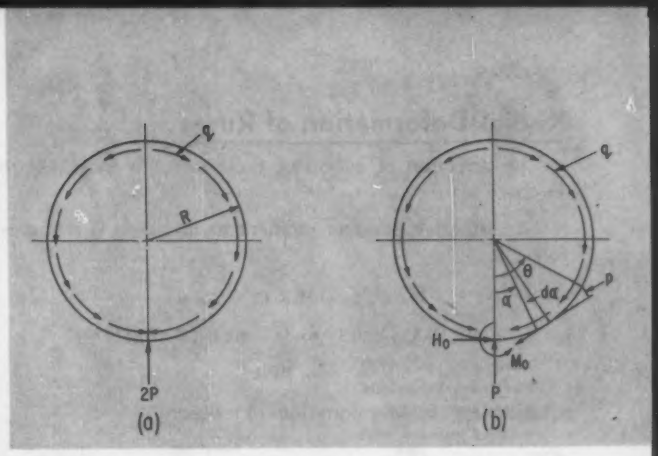


FIGURE 1—A concentrated radial load of 2P, acting on a circular ring, produces a bending moment M_o and an axial load H_o.

THE CIRCULAR RING of constant flexural rigidity, loaded in its own plane, has been the subject of extensive analytical investigation, mainly directed at determining the bending moment, shear and axial load distributions. Little appears to have been done with regard to radial deflection and what information there exists on the subject is rather restricted in scope. Nevertheless, radial deformation presents in many instances a problem of considerable practical importance.

Radial deformation at any particular point in a ring, can be calculated by the energy method. The draw back of this approach lies in the fact that the deflection obtained is that of the point under consideration only. An attempt to establish the deflection at other points calls for a repetition of work with regard to individual points. This is an extremely laborious process, in spite of which no overall picture of the deformed ring is obtained. A less laborious method is clearly desirable, and is in fact available, through the solution of the general deflection equation for circular bars in bending.

$$\frac{d^2w}{d\theta^2} + w = -\frac{M_\theta}{EI} R^2 \quad . \quad . \quad . \quad . \quad (1)$$

Where w is the radial deflection, positive when inward, $M\Theta$ the bending moment at an angle Θ, EI the flexural rigidity of the ring cross section and R the radius of the ring.

The annular ring investigated in this paper is of the type used in providing for the transmission of transverse forces and moments into a circular shell. A generalized loading system of this type may be obtained by considering three separate loading conditions as follows:

- Concentrated radial load, 2P.
- Concentrated tangential load, 2Q.
- Concentrated moment, 2M.

The externally applied loads are balanced by a reactive shear in the cylindrical shell. The distribution of this reactive shear for the three loading cases considered is given by the standard shear flow equations. These equations, it must be pointed out, are only applicable to cases where the ring is rigid. However, for small diameter shells with sturdy rings, the assumed shear distribution may be regarded as reasonably satisfactory for design purposes. A general statement of the case would be that so long as the ring deformations are small, the standard shear flow equations are admissable.

There remains the matter of boundary conditions. It will be observed that the general deflection equation (1) is an ordinary differential equation of the second order, thus possessing two constants of integration. Two boundary conditions are therefore required for the evaluation of these constants. This may be achieved by considering the slope and deflection at specific points on the ring, unfortunately only one boundary condition can be established by inspection in every one of the cases considered. Thus the determination of the second boundary condition requires a separate analysis directed at finding, preferably, the deflection rather than the slope at a convenient point on the ring. This may be done by applying an hypothetical radial load at the point of interest and calculating its deflection by the principle of strain energy. Admittedly, this is not a particularly elegant mode of approach, but is offset by the fact that it does offer a way out to a practical solution.

Concentrated Radial Load. Consider the ring in Figure 1a which is subject to a concentrated radial load of 2P.

The reactive shear distribution g is given by the equation

$$q = \frac{2P}{\pi R} \sin \Theta \quad . \quad . \quad . \quad . \quad (2)$$

The bending moment m due to the reactive shear q at an angle Θ measured from the origin shown in Figure (1c) is

$$m = \int_o^\theta q \cdot p \cdot R \, d\alpha$$

$$= \frac{2PR}{\pi} \int_o^\theta \sin \alpha \, [\, 1 - \cos (\Theta - \alpha) \,] \, d\alpha$$

$$= \frac{2PR}{\pi} \left(1 - \cos \Theta - \frac{\Theta}{2} \sin \Theta \right) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where

$$p = R \, [\, 1 - \cos (\Theta - \alpha) \,]$$

If a hypothetical cut is effected in the ring at $\Theta = o$, the reactive forces operating there, namely, a bending moment M_o and an axial load H_o are

$$M_o = 0.477 \, PR$$

$$H_o = 0.477 \, P$$

Radial Deformation of Rings . . .

The direction of action of these forces is indicated in Figure (1)

The effective bending moment at an angle Θ is therefore.

$$M_\theta = M_o + H_oR\,(1 - \cos\Theta) - m - PR\sin\Theta$$
$$= PR\,[0.318 + 0.16\cos\Theta - \sin\Theta\,(1 - 0.318\,\Theta)]$$
$$= \beta PR$$

substituting for M_θ, equation (1) becomes,

$$\frac{d^2w}{d\theta^2} + w = -\frac{PR^2}{EI}\,[0.318 + 0.16\cos\Theta - \sin\Theta\,(1 - 0.318\,\Theta)] \quad \ldots\ldots\ (4)$$

The general solution for w, consisting of a homogeneous and particular solution is:

$$w = A\sin\Theta + B\cos\Theta - \frac{PR^2}{EI}$$
$$(0.318 + 0.5\,\Theta\cos\Theta + 0.1595\,\Theta\sin\Theta - 0.0795\,\Theta^2\cos\Theta) \quad \ldots\ldots\ (5)$$

It is now necessary to determine the constants of integration "A" and "B." From the condition of symmetry,

$$\frac{1}{R}\frac{dw}{d\Theta} = 0 \qquad \text{at } \Theta = 0$$
$$A = 0.5\frac{PR^2}{EI}$$

To determine B, the radial deflection of the applied load 2P is calculated. If u is the strain energy due to bending then,

$$w_{\theta=o} = \frac{\partial u}{\partial P} = \frac{R}{EI}\int_o^\pi M_\theta\frac{\partial M_\theta}{\partial P}d\Theta$$
$$= \frac{PR^2}{EI}\int_o^\pi [0.318 + 0.16\cos\Theta - \sin\Theta\,(1 - 0.318\,\Theta)]^2\,d\Theta$$
$$= 0.0848\frac{PR^2}{EI}$$

For $\Theta = o$ equation (5) assumes the form

$$w_{\theta=o} = B - 0.318\frac{PR^2}{EI}$$

substituting for $w_\theta = o$

$$B = 0.4028\frac{PR^2}{EI}$$

substituting for A and B in equation (5).

$$w = \frac{PR^2}{EI}\,[\sin\Theta\,(0.5 - 0.1595\,\Theta) + \cos\Theta\,(0.4028 - 0.5\,\Theta + 0.0795\,\Theta^2) - 0.318]. \quad \ldots\ldots\ (5.1)$$
$$= \alpha\frac{PR^2}{EI}$$

TABLE 1—Bending Moment, Radial Deflection and Slope Coefficients Due to a Concentrated Radial Load 2P

Angle Θ	Radial Deflection α	Bending Moment β	Slope γ
0	0.0848	0.4770	0
30	0.0314	0.0391	—0.1612
60	—0.0458	—0.1802	—0.1260
90	—0.0680	—0.1820	0.0268
120	—0.0259	—0.0504	0.1176
150	0.0364	0.0967	0.1006
180	0.0645	0.159	0

The equation for the slope at any point is:

$$\frac{1}{R}\frac{dw}{d\Theta} = \frac{PR^2}{EI}\,(0.5\,\Theta - 0.0795\,\Theta^2 - 0.562)\sin\Theta \quad \ldots\ (6)$$
$$= \gamma\frac{PR^2}{EI}$$

With general equations for the bending moment distribution, deflection and slope, the coefficients of which are given in table 1, a complete description of the behavior of a ring under a concentrated radial load becomes available.

Tangential Load 2Q. Consider the ring shown in Figure 2a which is subject to a concentrated tangential load 2Q.

For reasons of analytical convenience, and using the principle of superposition, the actual loading case may be broken up into two separate but equivalent loading cases. The latter, shown in Figure 2b and Figure 2c are referred to as loading cases (1) and (2) respectively.

Case 1. The circumferential reactive shear per unit length is

$$q_1 = \frac{2Q}{\pi R}\cos\Theta \quad \ldots\ldots\ (7)$$

and the bending moment due to q_1 at a angle Θ is

$$m = \int_o^\theta q_1 \cdot p \cdot R\,d\alpha = \frac{QR}{\pi}\left(\frac{3}{2}\sin\Theta - \Theta\cos\Theta\right)$$

with α and p having the same significance as in the loading case previously considered.

To establish the over-all bending moment at an angle Θ the reactive forces operating at an hypothetical cut in the ring at $\Theta = 0$ must first be determined. This can be done by inspection.

From consideration of symmetry and asymmetry of the reactive shear with respect to the horizontal and vertical axis of symmetry respectively and asymmetry of the tangential load Q with respect to the vertical axis of symmetry, it is clear that the reactive elements are zero.

$$\text{i.e. } M_{o_1} = H_{o_1} = V_{o_1} = 0 \quad \text{at } \Theta = 0$$

The effective bending moment equation thus becomes

$$M_{o_1} = QR\left[\frac{1 - \cos\Theta}{2} - \frac{1}{\pi}\left(\frac{3}{2}\sin\Theta - \Theta\cos\Theta\right)\right] \quad \ldots\ (8)$$

Case 2. Following the same process of analysis as in case 1, the circumferential reactive shear per unit length is

$$q_2 = \frac{Q}{\pi R} \quad \ldots\ldots\ (9)$$

and the bending moment due to q_2 at an angle Θ is

$$m = \int_o^\theta q_2 \cdot p \cdot R\,d\alpha$$
$$= \frac{QR}{\pi}\,(\Theta - \sin\Theta)$$

From considerations of asymmetry of the reactive shear and the tangential load Q with respect to the vertical axis of symmetry of the ring, only one reactive element V_{o_2} operates at the hypothetical cut in the ring at $\Theta = o$.

$$V_{o_2} = \frac{Q}{\pi}$$

the value of V_{o_2} being determined by treating it as an indeterminate reaction. Its direction of action is indi-

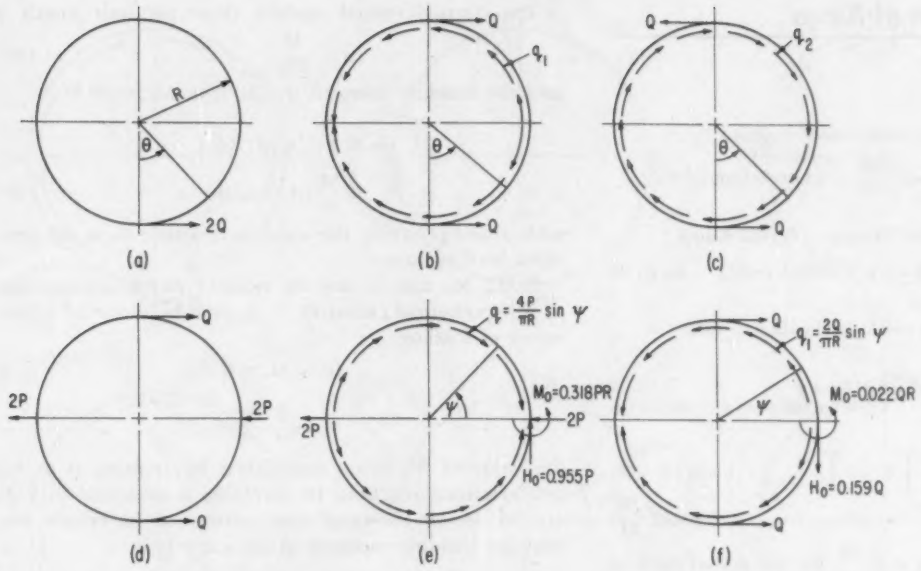


FIGURE 2—A circular ring subjected to a concentrated load of 2Q may be considered for analytical convenience as two separate but equivalent loading cases.

cated in Figure 2c. The effective bending moment at an angle Θ thus becomes

$$M_{\theta_2} = -V_{\theta_2} R \sin \Theta + \frac{Q}{2} R (1 - \cos \Theta) - m$$

$$= QR\left[\frac{1 - \cos \Theta}{2} - \frac{\Theta}{\pi}\right] \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The bending moment at angle Θ of the actual loading case is obtained by combining M_{θ_1} and M_{θ_2}

$$M_\theta = M_{\theta_1} + M_{\theta_2} = QR\left[(1 - \cos \Theta)\left(1 - \frac{\Theta}{\pi}\right) - \frac{3}{2\pi} \sin \Theta\right]$$

$$= \beta QR \quad . \quad . \quad . \quad (11)$$

substituting for M_θ in equation (1)

$$\frac{d^2w}{d\Theta^2} + w = -\frac{QR^2}{EI}\left[(1 - \cos \Theta)\left(1 - \frac{\Theta}{\pi}\right) - \frac{3}{2\pi} \sin \Theta\right] \quad (12)$$

The general solution of equation (12) is

$$w = A \sin \Theta + B \cos \Theta - \frac{QR^2}{EI}\left[1 - \frac{\Theta}{\pi}(1 - \cos \Theta) - \frac{\Theta}{2} \sin \Theta + \frac{\Theta^2}{4\pi} \sin \Theta\right]. \quad (13)$$

Where A and B are constants of integration to be determined from two boundary conditions.

Referring to Figure 2a, by virtue of asymmetry of loading with respect to the vertical axis of symmetry, the radial deflection at $\Theta = 0$ and $\Theta = \pi$ are zero. Substituting this condition in (13).

$$B = \frac{QR^2}{EI}$$

Referring to Figure 2b, asymmetry of loading with respect to the vertical axis of symmetry leads to the conclusion that the radial deflections at $\Theta = 0$ and $\Theta = \pi$ are zero. Similarly, referring to Figure 2c, asymmetry with respect to both axis of symmetry of the ring leads to the conclusion that the radial deflection at

$$\left.\begin{array}{l}\Theta = 0 \\ \Theta = \pi/2 \\ \Theta = \pi \\ \Theta = \frac{3}{2}\pi\end{array}\right\} w = 0$$

Thus, the deflection at $\Theta = \frac{\pi}{2}$ is the same in both the actual loading case and case 1. The evaluation of A in equation (13) may therefore be carried out through calculating the deflection at $\Theta = \frac{\pi}{2}$ for case (1). To do that hypothetical loads 2P are applied at $\Psi = 0$ and $\Psi = \pi$ as indicated in Figure 2d. It will be observed that the placing of loads 2P is such that the form of loading of the ring remains unaltered. This is an important point which must not be overlooked. For convenience, the bending moments at any angle Ψ measured from the horizontal axis, due to Q and 2P are written separately. Since the loading is symmetrical with respect to the horizontal axis, the reactive elements operating at an hypothetical cut in the ring at $\Psi = 0$ are a moment M_o and an axial load H_o. Their magnitude and direction are indicated in Figure 2e and 2f. They are determined by the usual procedure followed in treating indeterminate reactions.

The bending moment due to loading Q, Figure 2f, is

$${}_QM_\psi = QR\left[\frac{1}{2} - 0.4776 \cos \psi - 0.318 \psi \sin \psi\right] - \{QR (1 - \sin \psi)\}$$

the term in the curved brackets becoming effective only when $\Psi > \frac{\pi}{2}$. Similarly the bending moment due to loading 2P, Figure (2e), is

$${}_{2P}M_\psi = PR (0.318 \cos \psi + 0.6366 \psi \sin \psi - \sin \psi)$$

The effective bending moment for the combined loading is

$$M_\psi = QR\left[\frac{1}{2} - 0.4776 \cos \psi - 0.318 \psi \sin \psi\right] - \{QR (1 - \sin \psi)\}$$

$$+ PR (0.318 \cos \psi + 0.6366 \psi \sin \psi - \sin \psi)$$

The radial deflection of the hypothetical load is given by the equation

$$w_{\psi=o} = \frac{R}{EI}\int_o^{\pi} M_\psi \frac{\partial M_\psi}{\partial P} d\psi \quad \ldots \quad (14)$$

$$\frac{\partial M_\psi}{\partial P} = R\,(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)$$

Substituting for M_ψ and $\frac{\partial M_\psi}{\partial P}$ in equation (14)

$$w_{\psi=o} = \frac{QR^3}{EI}\int_o^{\pi}\left(\frac{1}{2} - 0.4776\cos\psi - 0.3183\,\psi\sin\psi\right)(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)\,d\psi$$

$$+\frac{PR^2}{EI}\int_o^{\pi}(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)^2\,d\psi$$

$$-\frac{QR^3}{EI}\int_{\frac{\pi}{2}}^{\pi}(1-\sin\psi)(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)\,d\psi$$

$$= 0.00485\frac{QR^3}{EI} + \frac{PR^2}{EI}\Big[\,f(\psi)\,\Big]_o^{\pi} \qquad \text{Since } 2P = 0$$

$$w_{\psi=o} = 0.00485\frac{QR^3}{EI}$$

i.e. the radial deflection at $\Theta = \frac{\pi}{2}$ for the actual loading case shown in Figure 2a is $0.00485\,\frac{QR^3}{EI}$.

On the basis of this boundary condition, A may now be determined.

$$0.00485\frac{QR^3}{EI} = A - \frac{QR^2}{EI}\left[1 - \frac{1}{2} - \frac{\pi}{4} + \frac{\pi}{16}\right]$$

$$A = -0.08315\frac{QR^2}{EI}$$

Substituting for A and B in equation (13).

$$w = \frac{QR^3}{EI}\left[\sin\Theta\left(\frac{\Theta}{2} - \frac{\Theta^2}{4\pi} - 0.08315\right) + \cos\Theta\left(1 - \frac{\Theta}{\pi}\right) + \frac{\Theta}{\pi} - 1\right] \quad \ldots \quad (14.1)$$

$$= \alpha\frac{QR^3}{EI}$$

and the slope at an angle Θ is

$$\frac{1}{R}\frac{dw}{d\Theta} = \frac{QR^2}{EI}\left[\frac{1}{\pi} + \sin\Theta\left(\frac{\Theta}{2\pi} - 0.5\right) + \cos\Theta\left(\frac{\Theta}{2} - \frac{\Theta^2}{4\pi} - 0.401\right)\right] \quad \ldots \quad (15)$$

$$= \gamma\frac{QR^2}{EI}$$

With general expressions for the bending moment distribution, deflection and slope, the coefficients of which are given in Table 2, a complete description is presented of the behavior of a ring under a concentrated tangential load.

TABLE 2—Bending Moment, Radial Deflection and Slope Coefficients Due to a Concentrated Tangential Load 2Q

Angle Θ	Radial Deflection α	Bending Moment β	Slope γ
0	0	0	—0.083
30	—0.0542	—0.1273	—0.0299
60	—0.0274	—0.0805	0.0468
90	0.0058	0.0225	0.0680
120	0.0327	0.0862	0.0252
150	0.0291	0.0726	—0.0380
180	0	0	—0.0674
210	—0.0291	—0.0726	—0.0380
240	—0.0327	—0.0862	0.0252
270	—0.0058	—0.0225	0.0680
300	0.0274	0.0805	0.0468
330	0.0542	0.1273	—0.0299
360	0	0	—0.083

Concentrated moment 2M. Consider the ring shown in Figure 3a which is subject to a concentrated moment of 2M.

The circumferential reactive shear per unit length is

$$q = \frac{M}{\pi R^2} \quad \ldots \quad (16)$$

and the bending moment due to q at an angle Θ is

$$m = \int_o^{\Theta} q \cdot p \cdot R\,d\alpha = \frac{M}{\pi}(\Theta - \sin\Theta) \quad \ldots \quad (17)$$

with α and p having the same significance as in the previous loading case.

If H_o, M_o and V_o are the reactive elements operating at a hypothetical cut at $\Theta = 0$, then by virtue of asymmetry of loading

$$H_o = M_o = 0$$

and

$$V_o = \frac{3}{\pi}\frac{M}{R}$$

the value of V_o being established by treating it as an indeterminate reaction. Its direction is indicated in Figure 3d. Using the same sign convention as before, the effective bending moment at an angle Θ is

$$M_\Theta = -V_o R\sin\Theta - m + M = M\left[1 - \frac{1}{\pi}(2\sin\Theta + \Theta)\right] \quad \ldots \quad (18)$$

$$= \beta M$$

substituting for M_Θ in equation (1)

$$\frac{d^2w}{d\Theta^2} + w = -\frac{MR^2}{EI}\left[1 - \frac{1}{\pi}(2\sin\Theta + \Theta)\right]$$

and the general solution of this equation is

$$w = A\sin\Theta + B\cos\Theta - \frac{MR^2}{EI}\left[1 - \frac{\Theta}{\pi}(1 - \Theta\cos\Theta)\right] \quad \ldots \quad (19)$$

where A and B are constants of integration to be determined from two boundary conditions.

Referring to Figure 3a, by virtue of asymmetry of loading with respect to the vertical axis of symmetry, the radial deflection at $\Theta = 0$ is zero.

Substituting this condition in equation (19)

$$B = \frac{MR^2}{EI}$$

A second boundary condition is now required for the determination of A. Following the procedure adopted in the case of the concentrated tangential load, the actual loading case is resolved into two equivalent cases shown in Figure 3b and 3c.

Referring to the loading case shown in Figure 3b, by virtue of asymmetry of loading with respect to the vertical axis of symmetry, the radial deflections at $\Theta = 0$ and $\Theta = \pi$ are zero.

Similarly, referring to the loading case shown in Figure 3c, by virtue of asymmetry of loading with respect to both axis of symmetry, the radial deflections at

$$\left.\begin{aligned}\Theta &= 0\\ \Theta &= \frac{\pi}{2}\\ \Theta &= \pi\\ \Theta &= 3\,\frac{\pi}{2}\end{aligned}\right\} \quad \text{are zero.}$$

Thus the radial deflection at $\Theta = \frac{\pi}{2}$ pertaining to the actual loading is identical with that occurring in the loading case shown in Figure 3c.

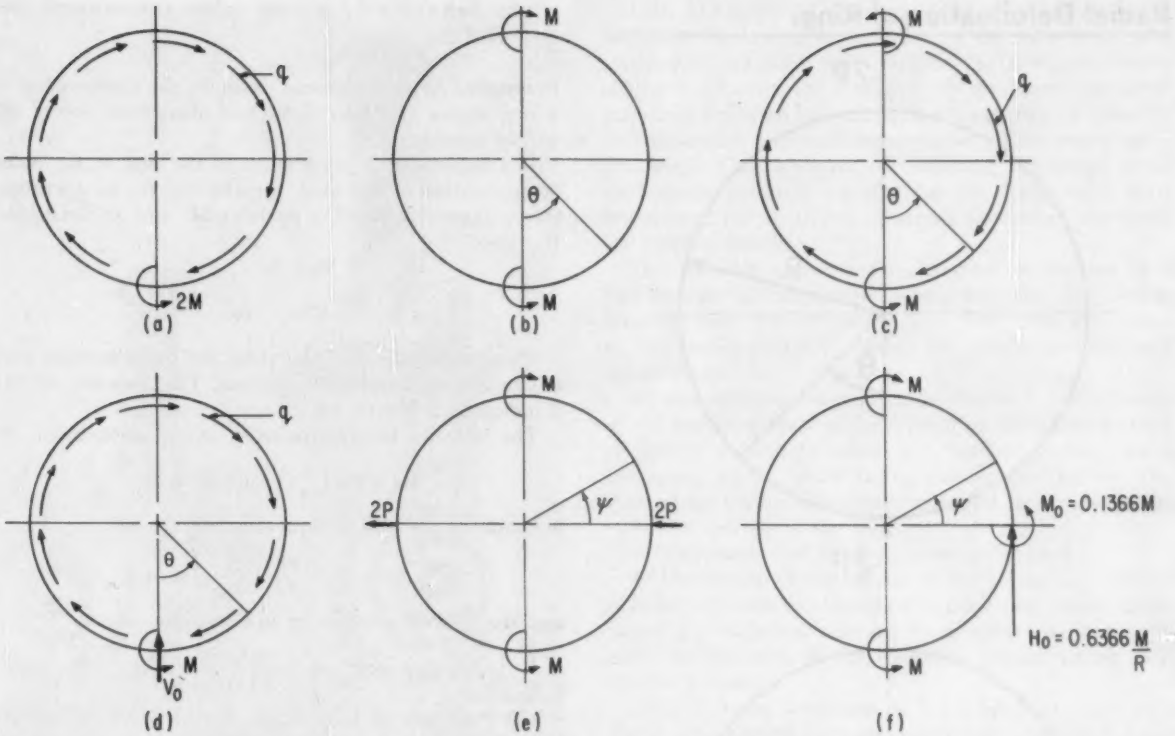


FIGURE 3—A circular ring acted upon by a concentrated moment 2M may be considered as two separate moments acting on the ring. Circumferential reactive shear is shown as q.

By applying hypothetical loads 2P at $\Psi = o$ and $\Psi = \pi$ in the manner indicated in Figure 3e, the actual form of loading remains unaltered and the deflection at $\Psi = o$ is given by

$$w_{\psi=o} = \frac{R}{EI}\int_o^{\pi} M_\psi \frac{\partial M_\psi}{\partial P}\, d\psi \qquad (20)$$

where M_ψ is the over-all bending due the applied moment M and loads 2P.

The bending moment due to the action of 2P alone, as established in the foregoing analysis is

$$_{2P}M_\psi = PR\,(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi$$

The bending moment due to M alone is arrived at by evaluating first the reactions operating at $\Psi = o$. Since the loading is symmetrical about the horizontal axis, the reactions are a moment M_o and an axial load H_o. These are calculated by the usual methods used in determining indeterminate reactions. Their values and directions are indicated in Figure 3f.

$$_{M}M_\psi = M\,(0.5 - 0.6366\cos\psi) - \{M\}$$

The term in the curved brackets becoming effective only when $\Psi > \frac{\pi}{2}$

Thus

$$M_\psi = M\,(0.5 - 0.6366\cos\psi) - \{M\} + PR\,(0.318\cos\psi + 0.6366\,\Theta\sin\Theta - \sin\Theta)$$

Substituting for M_Ψ in equation (20)

$$w_{\psi=o} = \frac{MR^2}{EI}\int_o^{\pi}(0.5 - 0.6366\cos\psi)\,(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)\,d\psi + \frac{PR^3}{EI}\int_o^{\pi}(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)^2\,d\psi$$

$$-\frac{MR^2}{EI}\int_{\frac{\pi}{2}}^{\pi}(0.318\cos\psi + 0.6366\,\psi\sin\psi - \sin\psi)\,d\psi$$

$$= -0.0451\frac{MR^2}{EI} + \frac{PR^3}{EI}\Big[(f(\psi)\Big]_o^{\pi}$$

Since

$$P = 0$$

$$w_{\psi=o} = -0.0451\frac{MR^2}{EI}$$

The negative sign indicating an outward deflection.

Substituting this condition in equation (19)

$$-0.0451\frac{MR^2}{EI} = A - \frac{MR^2}{EI}\left[1 - \frac{1}{2}\left(\frac{\pi}{2}\right)\right]$$

$$A = 0.4549\frac{MR^2}{EI}$$

Substituting for A and B in 19.

$$w = \frac{MR^2}{EI}\left[0.459\sin\Theta + \cos\Theta + \frac{\Theta}{\pi}(1 - \cos\Theta) - 1\right] \qquad (21)$$

$$= \alpha\frac{MR^2}{EI}$$

and the slope at any angle Θ is:

$$\frac{1}{R}\frac{dw}{d\Theta} = \frac{MR}{EI}\left[0.1366\cos\Theta + \sin\Theta\left(\frac{\Theta}{\pi} - 1\right) + \frac{1}{\pi}\right]$$

$$= \partial\frac{MR}{EI} \qquad (22)$$

With the general expressions for the bending moment distribution, deflection and slope, the coefficients which are given in Table 3, a complete description is presented

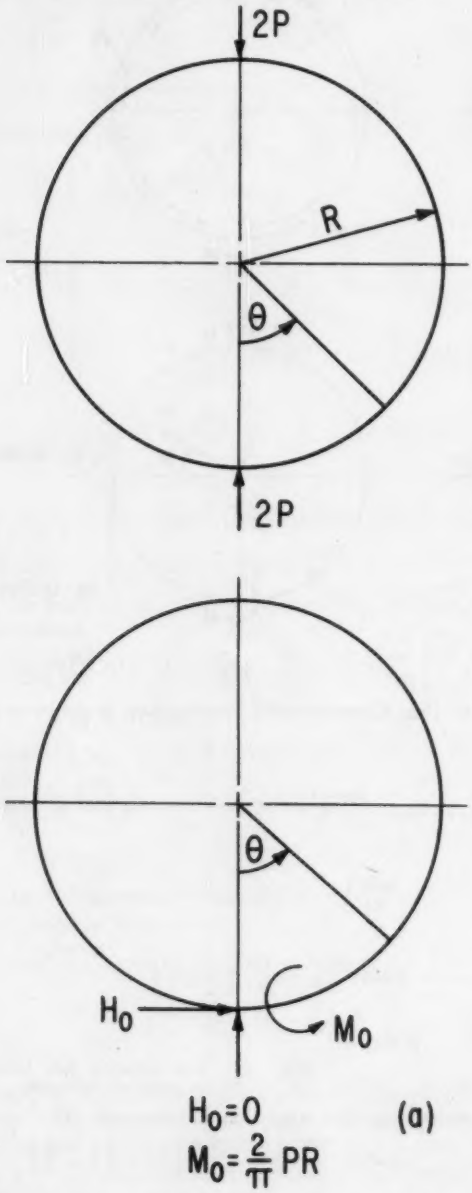


FIGURE 4—This example presents a ring in compression by two diametral forces each equivalent to 2P.

TABLE 3—Bending Moment, Radial Deflection and Slope Coefficients Due to a Concentrated Moment 2M

Angle Θ	Radial Deflection α	Bending Moment β	Slope γ
0	0	1.00	0.4549
30	0.1166	0.5151	0.0200
60	0.0609	0.1154	—0.1911
90	—0.0451	—0.1366	—0.1817
120	—0.1061	—0.2184	—0.0389
150	—0.0836	—0.1516	0.1167
180	0	0	0.1817
210	0.0836	0.1516	0.1167
240	0.1061	0.2184	—0.0389
270	0.0451	0.1366	—0.1817
300	—0.0609	—0.1154	—0.1911
330	—0.1166	—0.5151	0.0200
360	0	—1.00	0.4549

of the behavior of a ring under concentrated moment 2M.

Example. As an additional example, the compression of a ring shown in Figure 4, by two diametrical forces 2P, will be considered.

If a hypothetical cut is made in the ring at the point of application of the load, the reactive forces operating there, namely, a bending moment M_o and an axial load H_o, are:

$$H_o = 0$$

$$M_o = \frac{2}{\pi} PR.$$

These values are calculated by the usual method pertaining to indeterminate reactions. The direction of M_o is indicated in Figure 4a.

The effective bending moment at an angle Θ is

$$M_\Theta = PR\left(\frac{2}{\pi} - \text{Sin}\,\Theta\right) = \beta\, PR$$

Substituting for M_Θ in equation (1)

$$\frac{d^2w}{d\Theta^2} + w = -\frac{PR^2}{EI}\left(\frac{2}{\pi} - \text{Sin}\,\Theta\right)$$

and the general solution of this equation is

$$w = A\sin\Theta + B\cos\Theta - \frac{PR^2}{EI}\left(\frac{2}{\pi} + \frac{\Theta}{2}\text{Cos}\,\Theta\right)$$

The constants of integration A and B are calculated from the boundary conditions. These are:

$$\frac{dw}{d\Theta} = o \text{ at } \Theta = o$$

$$\frac{dw}{d\Theta} = o \text{ at } \Theta = \frac{\pi}{2}$$

$$\frac{dw}{d\Theta} = A\cos\Theta - B\sin\Theta - \frac{PR^2}{2\,EI}(-\Theta\sin\Theta + \cos\Theta)$$

from which

$$A = \frac{PR^2}{2\,EI}$$

$$B = \frac{PR^2}{4\,EI}\cdot\pi$$

Substituting for A and B in the equation for w:

$$w = \frac{PR^2}{2\,EI}\left[\sin\Theta + \cos\Theta\left(\frac{\pi}{2} - \Theta\right) - \frac{4}{\pi}\right]$$

$$= \alpha\frac{PR^2}{EI}$$

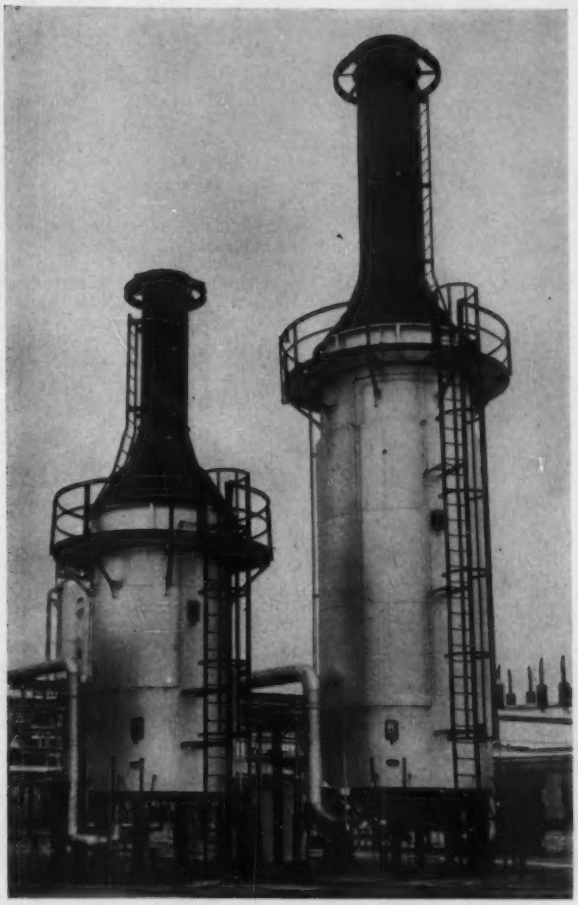
$$\frac{1}{R}\frac{dw}{d\Theta} = \frac{PR^2}{2\,EI} \times \left[\sin\Theta\,(\Theta - \pi/2)\right] = \gamma\frac{PR^2}{EI}$$

The values of the radial deflection, slope and bending moment coefficients are given in Table 4.

TABLE 4—Bending Moment, Radial Deflection and Slope Coefficients Resulting From Two Diametrical Compressive Forces

Angle Θ	Radial Deflection α	Bending Moment β	Slope γ
0	0.1488	0.6366	0
15	0.1257	0.3776	—0.1695
30	0.0672	0.1366	—0.2618
45	—0.0058	—0.0704	—0.2776
60	—0.0727	—0.2294	—0.2268
75	—0.1194	—0.3304	—0.1260
90	—0.1366	—0.3634	0

The coefficients given in the tables may be plotted against 'Θ', so that their values at any angle may be readily obtained. ##



Typical vertical furnaces. Basic in their design is the calculation of maximum expected tube-wall temperatures.

Calculate Heater Tube Temperatures

Use this method for calculating maximum tube-wall temperatures and for the selection of tube material and wall thickness.

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THE MAXIMUM temperature in a fired heater tube wall must be known for selection of the tube metal and specification of tube wall thickness. In the cases where coking is a factor, the fluid velocity and hence the pressure drop are often influenced by the necessity of reducing the maximum tube-wall temperature below some specified level. Thus a means of estimating maximum tube-wall temperatures is essential for the design of a fired heater and for specifying alternate operating conditions for existing heaters.

This analysis accounts for variation of radiant heat flux around the circumference of a tube and the circumferential heat transfer in the tube wall from the hotter to the cooler points to obtain the maximum tube-wall temperature.

At any cross section such as in Figure 1, the intensity of the radiation received by a point on the circumference of one of a bank of tubes in a furnace varies from a maximum at the point facing the furnace cavity. The form of the variation depends on several factors including,

- The spacing of the tubes,
- The number of rows of tubes in the bank
- The nature of the surface of the tubes, i.e., whether it is dull or metallic. (Lambert's cosine law, which determines the radiation received by a surface at any angle with the direction of the radiation, applies strictly only to dull surfaces.)

The following treatment is for a bank of tubes in a single row, backed by a refractory wall. Assuming Lambert's cosine law is applicable gives results that are conservative for tubes having polished metallic surfaces.

The radiation received at any point on the cross-section of a tube will be limited by the angle through which the point can "see," fixed by the tangent at the

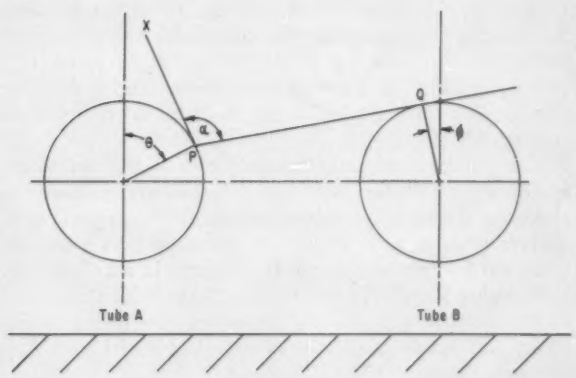


FIGURE 1—Point P on the cross-section of tube A receives direct radiation through angle α, which is limited by the tangent, PX, at P and the vector, PQ, making a tangent with tube B.

point and the tangent from the point to the neighboring tube. (See Figure 1.)

By expressing the coordinates of the points P and Q in Figure 1, in terms of Θ and ϕ respectively and writing the condition that PQ is a tangent at Q, the following relation is obtained.

$$\cos(\Theta + \phi) = 1 - \frac{D}{R}\sin\phi \qquad (1)$$

From the geometry of the situation it follows that,

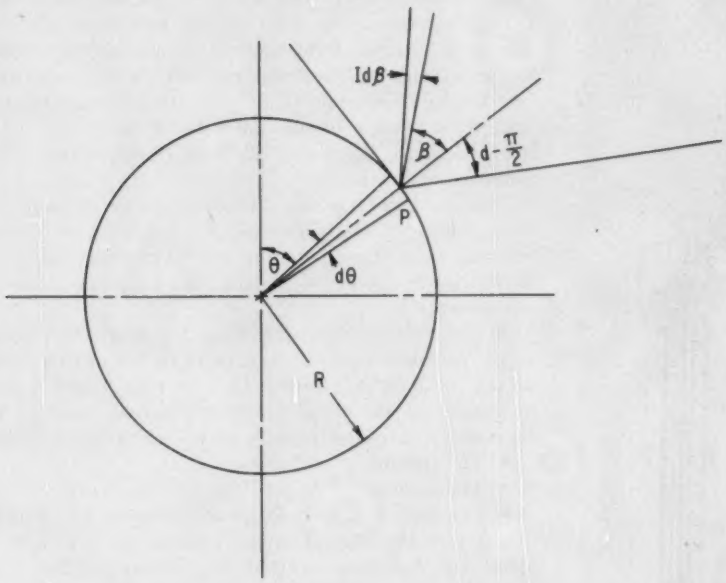
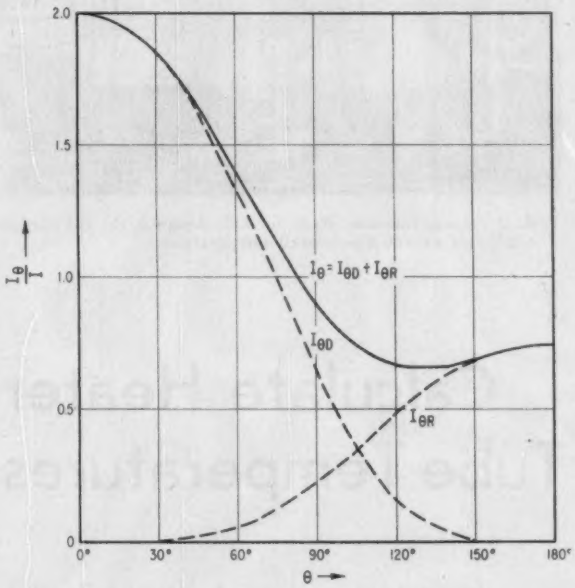


FIGURE 2 (left)—P marks the cross-section of the laminar strip on the tube's surface, of unit length axially and of width Rdθ. The radiation absorbed from a direction making an angle β with the normal to the element, is given by Lambert's cosine law to be Id β cos β Rd Θ.

FIGURE 3 (below)—Here is shown the variation of radiant intensity around the circumference of a tube, for a tube spacing of two diameters.



α, the angle included between PX and PQ is given by Equation (2).

$$\alpha = \pi - (\theta + \phi) \quad (\alpha, \theta, \phi \text{ expressed in radians}) \qquad (2)$$

Having established the geometrical relationships, governing the angle through which P can "see" the intensity of the radiation received at P can now be calculated. In general, P will receive radiation directly from the furnace cavity and also by reflection from the refractory backing. At this stage consider only the contribution due to direct radiation; this means that, therefore, in Equation (1), when two values of ϕ are obtained for a given Θ, only the solution for the value of ϕ less than 90 degrees will be considered.

The oil and gas fired heaters used in the petroleum industry have flames with small luminosity, in fact gas yields an almost non-luminous flame. It is thus possible to assume with a high degree of accuracy that radiation from the furnace cavity will be uniform in all directions.

Applying Lambert's cosine law, the radiation absorbed at the laminar strip on the surface of the tubes, of unit length and whose cross-section is marked P in Figure 2, is given by Equation (3):

$$I_p = \int_{-(\alpha - \pi/2)}^{\pi/2} Id\beta \cdot \cos\beta \cdot Rd\theta \qquad (3)$$

Where I is the product of the intensity of the incident radiation and the absorptivity of the tube surface. Assuming uniform radiation in all directions, I is independent of β.

Integrating Equation (3) gives

$$I_p = IRd\theta \left[1 + \sin\left(\alpha - \frac{\pi}{2}\right)\right] = IRd\theta \left[1 + \cos(\theta + \phi)\right]$$

$$\text{or} \quad I_{\theta D} = \frac{I_p}{Rd\theta} = I\left(1 + \cos(\theta + \phi)\right) \qquad (4)$$

where $I_{\theta D}$ is the direct radiation per unit area absorbed at an element of the tube's surface whose angular coordinate is Θ.

Direct radiation is received on the face of the tube symmetrically. On the right hand side of the tube in Figure 1 radiation is received through the angle from $\theta = 0$ to $\theta = \theta_1$ (where θ_1 is the angular coordinate of the point which is just totally shielded from direct radiation by the neighboring tube).

The value of θ_1 follows from Equation (1); Θ and ϕ increase from their simultaneous value of zero. As long as a tangent from P (angular coordinate Θ) on tube A to

the front fact of tube B can be drawn, the relationship expressed by Equation (1) will hold. The maximum value of ϕ for this equation to hold is given by

$$1 - \frac{D}{R}\sin\phi = -1,$$

since a larger value of ϕ will cause the equation to become an inequality.

Thus $\sin\phi_1 = 2R/D$

and $\theta_1 + \phi_1 = \cos^{-1}(-1) = 180°$

This result follows also from Equation (2) since $\alpha = 0_1$ for this condition.

The total direct radiation absorbed by one side of unit length of the tube is found by integrating the expression for I_p from 0 to Θ_1 i.e.,

$$I_D = IR\int_0^{\theta_1} d\theta\left[2 - \frac{D}{R}\sin\phi\right] \quad (5)$$

This is achieved as follows. Introducing the new variable x, defined by Equation (6)

$$x = 1 - \frac{D}{R}\sin\phi \quad (6)$$

Equation (1) becomes on rearrangement

$$\theta = (\cos^{-1}x) - \phi \quad (7)$$

and differentiating Equation (7) gives

$$d\theta = -\frac{dx}{\sqrt{1-x^2}} - d\phi \quad (8)$$

Substituting for $d\Theta$, expanding and partially substituting for $\sin\phi$ in Equation (5) gives

$$I_D = IR\left[-\int_{\theta=0}^{\theta=\theta_1}(1+x)\frac{dx}{\sqrt{1-x^2}} - \int_{\theta=0}^{\theta=\theta_1}\left(2 - \frac{D}{R}\sin\phi\right)d\phi\right]$$

which can be integrated giving

$$\frac{I_D}{IR} = \left[\cos^{-1}x\right]_{\theta=\theta}^{\theta=\theta_1} + \left[\sqrt{1-x^2}\right]_{\theta=0}^{\theta=\theta_1} - \left[2\phi + \frac{D}{R}\cos\phi\right]_{\theta=0}^{\theta=\theta_1} \quad (9)$$

The values of x and ϕ corresponding to $\Theta = 0$ and $\Theta = \Theta_1$ are as follows; when $\Theta = 0$

$$\phi = 0$$
$$x = 1 - \frac{D}{R}\sin\phi = 1$$

when

$$\theta = \theta_1$$
$$\phi = \phi_1 = \sin^{-1}\frac{2R}{D}$$
$$x_1 = 1 - \frac{D}{R}\cdot\frac{2R}{D} = -1$$

On substitution of the appropriate limits in Equation (9) and rearrangement of the result, Equation (10) is obtained.

$$\frac{I_D}{IR} = \frac{D}{R}\left(1 - \sqrt{1 - \left(\frac{2R}{D}\right)^2}\right) + 2\cos^{-1}\frac{2R}{D} \quad (10)$$

The radiation incident on the bank and not falling on the tubes falls on the refractory backing. Strictly, allowance should also be made for the reflection to neighboring tubes and to the refractory, of that part of the radiation which is incident on, but not absorbed by a tube. The tubes commonly used in fired heaters have high absorptivities and the amount of this radiation will be small and can be neglected. In this analysis it is assumed that all radiation reflected from a tube returns directly to the furnace cavity.

The radiation which would be absorbed by unit area of a plane surface having the absorptivity of the tube surfaces, is given by Equation (11), which follows from Lambert's cosine law.

$$S = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} I\cos\beta\cdot d\beta \quad (11)$$

i.e. $S = 2I$

For the area of the tube bank between the axes of tubes A and B, and extending for unit length axially, the "absorbable" radiation is $S \times D$. This radiation is intercepted by the right-hand half of Tube A and the left-hand half of tube B.

The fraction f of the "absorbable" direct radiation incident on the bank, intercepted and absorbed by tubes, is hence given by Equation (12).

$$f = \frac{2I_D}{S \times D} = \frac{I_D}{ID} \quad (12)$$

Assuming the refractory diffuses radiation with equal intensity in all directions, it follows that the same fraction f of the "absorbable" reflected radiation will be absorbed by the rear face of the bank of tubes. Thus assuming no losses from the refractory, the reflected radiation absorbed at any element of surface on the rear face of a tube is related to the direct radiation received at the corresponding element on the front face, by Equation (13).

$$I_{(\pi-\theta)R} = (1-f)\,I_{\theta D} \quad (13)$$
$$\text{and } I_R = (1-f)\,I_D \quad (14)$$

The variation of intensity of radiation over the surface of the tube for a tube spacing of two diameters is shown in Figure 3. The total direct and reflected radiation absorbed by one side of the tube can be expressed as follows

$$\frac{I_t}{IR} = \frac{I_D}{IR}\left[1 + (1-f)\right]$$
$$\text{or, } \frac{I_t}{IR} = \frac{fD}{R}\left[2 - f\right] \quad (15)$$

where from Equations (10) and (12)

$$f = \frac{R}{D}\left[\frac{D}{R}\left(1 - \sqrt{1 - \left(\frac{2R}{D}\right)^2}\right) + 2\cos^{-1}\frac{2R}{D}\right] \quad (16)$$

H, the average radiant rate is obviously related to I_t by the equation:

$$H = \frac{2I_t}{2\pi R} = \frac{ID}{\pi R}\,f\,(2-f) \quad (17)$$

From Equation (4), the maximum radiation intensity at any cross-section occurs at the point of the tube nearest the furnace cavity ($\Theta = 0$) and is of magnitude 2I

Thus

$$\frac{I_{max}}{H} = \frac{2\pi R}{Df(2-f)} \quad (18)$$

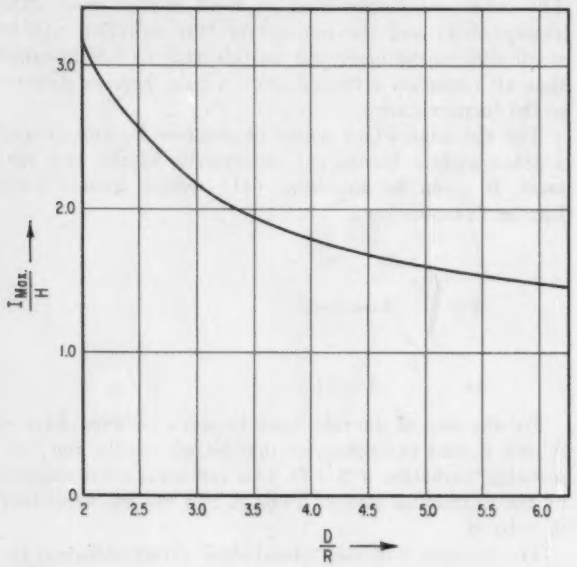


FIGURE 4—The variation of I_{max}/H with tube spacing is shown in this plot.

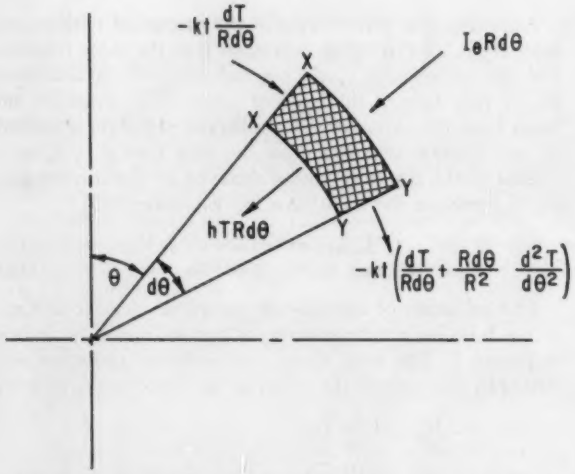


FIGURE 5—Consideration of the heat transfer to and from the element of the tube wall yields the terms shown above. The assumption has been made that the tube wall is thin compared with the diameter and that T is constant along radii such as XX and YY. For strict consistency, R, the radius used in deriving the terms, should be the mean radius of the tube wall, and I_θ and h should be referred to this radius. For thin walled tubes it is sufficiently accurate to use the tube outer radius for R.

TABLE 1

Comparison between cos Θ and cos (Θ+φ) for a tube spacing of two diameters.

Θ	Cos Θ	Cos (Θ + Ø)
0°	1	1
10°	0.985	0.98
20°	0.945	0.94
30°	0.866	0.84

This relationship is plotted in Figure 4.

An estimate of the maximum tube wall temperature can be obtained simply by dividing the maximum intensity from Equation (18) by the heat transfer coefficient h, of the fluid in the tube and adding to this the bulk temperature of the fluid.

$$\text{i.e. } T'_{max} = \frac{I_{max}}{h} \qquad (19)$$

This estimate is conservative for cases where h is small, owing to neglect of the effect of circumferential heat transfer in the tube wall.

Equation (20) expresses the heat transfer equilibrium to and from an infinitesimal element of the tube wall.

$$I_\theta = hT - \frac{kt}{R^2}\frac{d^2T}{d\theta^2} \qquad (20)$$

In the derivation of this equation, which is indicated in Figure 5, it is assumed that the tube wall temperature is approximately constant along any radius. This is justified if h is small which is just the condition for which this analysis is necessary.

For the front face of the tube, where only direct radiation is received.

$$I_\theta = I_{\theta D} = I\,(1 + \cos\,(\theta + \phi)\,)$$

For values of Θ near zero, ϕ varies very slowly with Θ and cos $(\theta + \phi)$ is approximated to a sufficient degree of accuracy by cos Θ. This is illustrated in Table 1 where cos $(\theta + \phi)$ is compared with cos Θ for a tube spacing of two diameters.

The complementary function of the governing equation is the solution obtained by equating to zero the right-hand side of Equation (20). This gives for the complementary function

$$A \cosh \gamma\theta + B \sinh \gamma\theta$$

where

$$\gamma = \sqrt{\frac{hR^2}{kt}}$$

and A and B are constants to be determined.

The particular integral for Equation (20) cannot be found analytically for the whole range of Θ from 0° to 180°, but an expression for T at small values of Θ can be obtained using the approximate form of I_θ which applies in this range. It is then possible to obtain T_{max}.

Rewritting Equation (20) in terms of the operator D gives,

$$\left(1 - \frac{D^2}{\gamma^2}\right)T = \frac{1}{h}\,I_\theta$$

Thus the particular integral is

$$\frac{1}{h}\left(1 + \frac{D^2}{\gamma^2} + \frac{D^4}{\gamma^4} + \frac{D^6}{\gamma^6} + \ldots\right) I_\theta$$

This general expression for T is given by the sum of the complementary function and the particular integral

$$T = A \cosh \gamma\theta + B \sinh \gamma\theta + \frac{1}{h}\left(1 + \frac{D^2}{\gamma^2} + \frac{D^4}{\gamma^4} + \ldots.\right) I_\theta \qquad (21)$$

The constants A and B are found from the boundary conditions. In this case from considerations of symmetry, $\frac{dT}{d\theta}$ is zero both at Θ = 0° and at Θ = 180°. For the ranges near these values of Θ, I_θ can be expressed by the equations

$I_\theta = I\,(1 + \cos\theta)$ for values of Θ near 0°

$I_\theta = I\,(1 - \cos\theta)\,(1 - f)$ for values of Θ near 180°

Differentiating Equation (21) gives

$$\frac{dT}{d\Theta} = \gamma A \sinh \gamma\Theta + \gamma B \cosh \gamma\Theta + \frac{1}{h}\left(D + \frac{D^3}{\gamma^2} + \frac{D^5}{\gamma^4} + \dots\right) I_\Theta$$

and when Θ is nearly zero

$$\frac{dT}{d\Theta} = \gamma A \sinh\gamma\Theta + \gamma B \cosh\gamma\Theta + \frac{1}{h}\left(-\sin\Theta + \frac{\sin\Theta}{\gamma^2} - \frac{\sin\Theta}{\gamma^4} + \dots.\right)$$

Substituting the condition that $\frac{dT}{d\Theta}$ is zero when Θ is zero, gives, $\gamma B = 0$

hence $B = 0$

Similarly the condition for $\Theta = 180°$ gives $A = 0$.

Thus the equation for T reduces to

$$T = \frac{I_\Theta}{h\left(1 - \frac{D^2}{\gamma^2}\right)}$$

and substituting for I_Θ gives, for small Θ

$$T = \frac{I\cos\Theta}{h\left(1 + \frac{1}{\gamma^2}\right)} + \frac{I}{h}$$

When Θ is zero, $T = T_{max}$ where

$$T_{max} = \frac{I}{h\left(1 + \frac{1}{\gamma^2}\right)} + \frac{I}{h}$$

Expressing T_{max} in terms of the quantities which are usually known directly, gives

$$T_{max} = \frac{\pi H}{\frac{D}{R} f\,(2 - f)\,h}\left(1 + \frac{1}{1 + \frac{kt}{hR^2}}\right)$$

Writing

$$T_{mean} = \frac{H}{h}$$ gives

$$T_{max} = \frac{\pi T_{mean}}{\frac{D}{R} f\,(2 - f)}\left(1 + \frac{1}{1 + \frac{kt}{hR^2}}\right)$$

and in terms of T'_{max}

$$T_{max} = \frac{1}{2} T'_{max}\left(1 + \frac{1}{1 + \frac{kt}{hR^2}}\right)$$

Thus for T_{max} to differ appreciably from T'_{max}, h must be comparable in magnitude to, or of smaller magnitude than the factor $\frac{kt}{R^2}$.

For a steel tube (K = 30 BTU/hr. ft. F) of 6" O.D. and ½" wall thickness, the value of the factor is 20, and Equation (24) becomes

$$T_{max} = \frac{1}{2} T'_{max}\left(1 + \frac{1}{1 + 20/h}\right)$$

In crude oil and asphalt heaters h is frequently as low as 20 BTU/ft.² F. hr.

Then $T_{max} = 0.75\, T'_{max}$

In the case the more accurate estimate T_{max}, is 25 percent smaller than T'_{max} obtained by neglecting the effects of circumferential heat transfer. A heater design based on T'_{max} would require a fluid velocity through the tubes 40 percent higher and a pressure drop nearly 90 percent higher than would a design based on a maximum tube wall temperature estimated by the relationship for T_{max}.

SYMBOLS USED

$Id\beta$, the product of the absorptivity of the tube surfaces and the radiation energy per unit area leaving the furnace cavity within a narrow wedge of angle $d\beta$; the area being measured in a plane normal to the median plane of the wedge; BTU/Hr. Sq. Ft.

I_p, the total radiation absorbed by the element P of a tube's surface; BTU/Hr.

$I_{\Theta D}$, the direct radiation per unit area of tube's outer surface, absorbed at an element of the tube's surface, whose angular coordinate is Θ; BTU/Sq. Ft. Hr.

I_D, the total of the direct radiation absorbed on one side of unit length of a tube; BTU/Hr.

$I_{\Theta R}$, the reflected radiation per unit area of tube's surface, absorbed at an element of the tube's surface whose angular coordinate is Θ; BTU/Hr. Sq. Ft.

I_R, the total of the reflected radiation absorbed on one side of unit length of a tube; BTU/Hr.

I_t, the total of direct and reflected radiation absorbed on one side of unit length of a tube; BTU/Hr.

I_Θ, the total radiation, direct and reflected, absorbed per unit area of tube's surface at an element of the tube's surface whose angular coordinate is Θ; BTU/Hr. Sq. Ft.

I_{max}, the maximum value of I_Θ, which occurs at the point of the cross-section of the tube nearest the furnace cavity, for which $\Theta = 0$; BTU/Hr. Sq. Ft.

S, the radiation incident on unit area of the bank of tubes, which would be absorbed by a surface having the absorptivity of the tubes i.e., the product of the absorptivity of the tube surface and the total radiation incident on the bank per unit area. BTU/Hr. Sq. Ft.

R, the outer radius of the tube; Ft.

D, the center-to-center spacing of adjacent tubes; Ft.

x, variable defined by Equation (6), and introduced for the purpose of integrating Equation (5).

f, the fraction of the direct radiation incident on the bank intercepted by the tubes.

T, the tube wall temperature at angular coordinate Θ. T is measured above the fluid temperature at the tube cross-section under consideration.

k, the thermal conductivity of the material of the tube wall; BTU/Hr. Ft. °F.

h, the heat transfer coefficient of the fluid film on the inside of the tube, referred to the outer radius of the tube, i.e., expressed as BTU/Hr. °F. per unit outer area of the tube; BTU/Hr. Sq. Ft. °F.

T_{max}, maximum value of T, which occurs at the point of the tube cross-section nearest the furnace cavity.

T'_{max}, estimate of T_{max} obtained by neglecting the effect of circumferential heat transfer.

t, the tube wall thickness, Ft.

α, the angle through which a point on the surface of the tube can "see." See Figure 1.

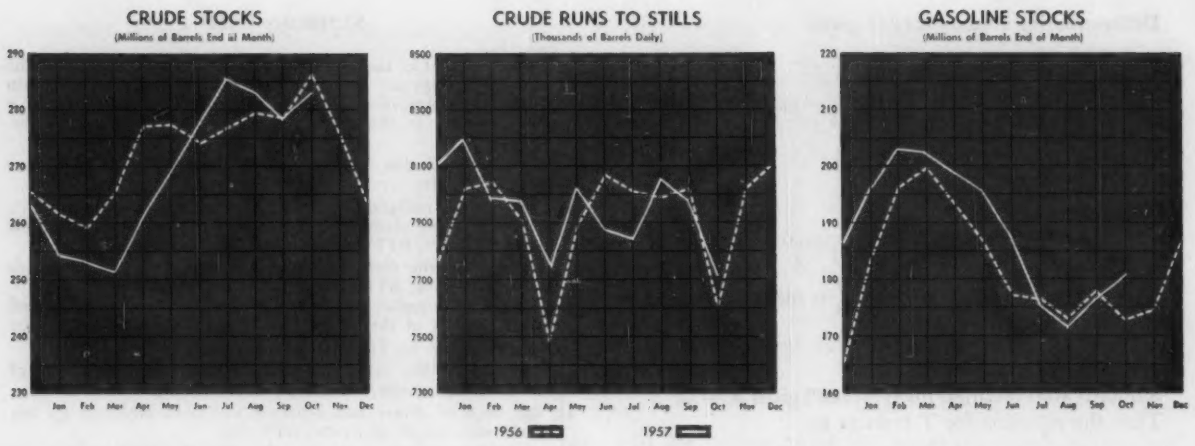
Θ, ϕ, see Figure 1.

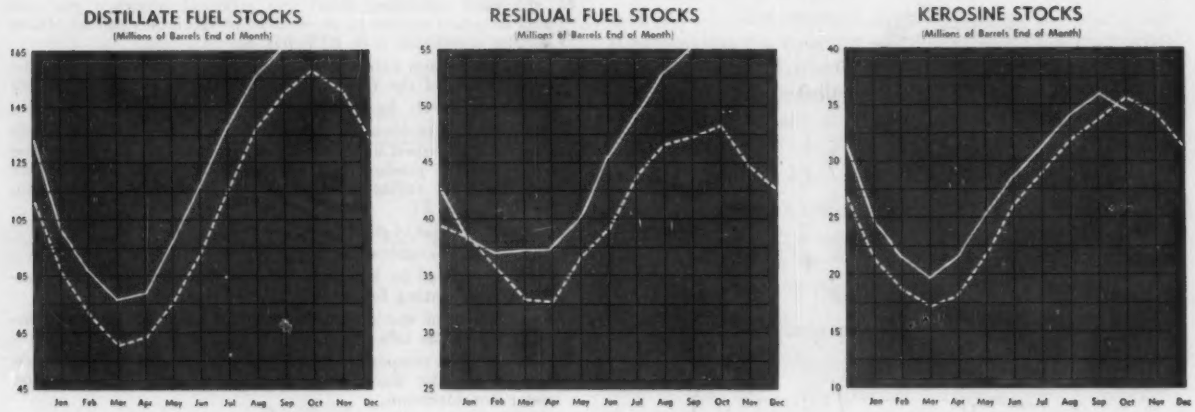
β, see Figure 2.

H, average radiant rate, obtained by dividing the total radiation received by a tube, by the outside area of the tube.

About the Author

A. Doll-Steinberg is a process engineer for Foster Wheeler, Ltd., London, where he has done work on catalytic cracking and reforming plates and fired heaters. Doll-Steinberg graduated from Cambride University, England, with First Class Honors in chemical engineering. Since the first of the year he has been gaining experience with Foster Wheeler in New York.




DISTILLATE FUEL STOCKS
(Millions of Barrels End of Month)
RESIDUAL FUEL STOCKS
(Millions of Barrels End of Month)
KEROSINE STOCKS
(Millions of Barrels End of Month)

Taking Stock

Cecil W. Smith
Economics Editor

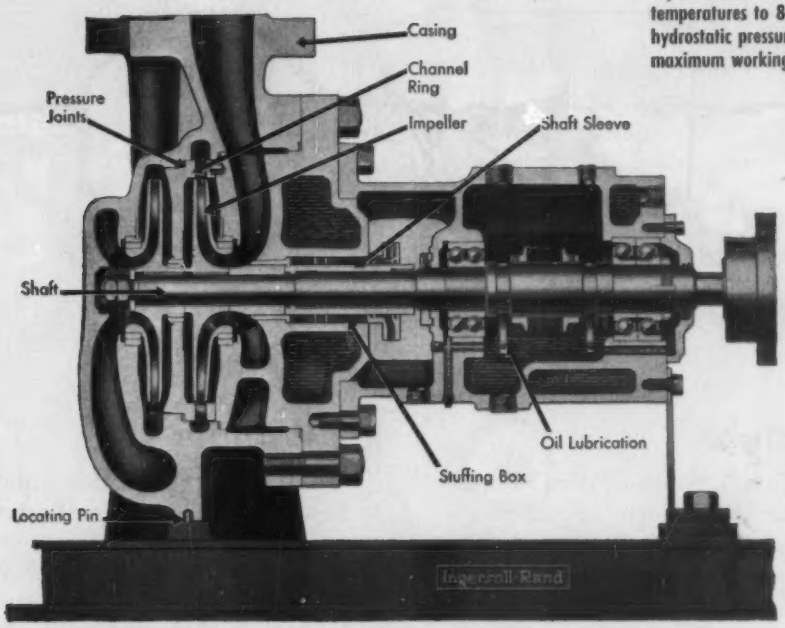
- Fuel oil stocks continue growth
- Kerosine inventories dip slightly
- Refinery runs at year's lowest

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:													
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	290	26,111	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	296	28,990	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	313	31,826	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	329	33,588	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	356	35,667	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	384	34,329	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	379	31,420	1,981	133,981	1,288	44,491	873	1,471
1957:													
January	7,480	8,274	256,669	3,991	197,702	367	24,019	2,118	100,572	1,322	38,403	805	1,425
February	7,682	8,088	256,344	3,864	205,270	353	21,013	2,035	85,105	1,270	31,201	780	1,430
March	7,717	8,047	254,911	3,826	206,716	332	20,223	1,861	76,245	1,205	37,371	836	1,464
April	7,541	7,740	265,796	3,770	201,407	284	21,512	1,764	78,743	1,132	37,429	906	1,542
May	7,442	7,992	275,963	3,900	195,094	272	25,545	1,789	98,135	1,103	41,125	1,042	1,558
June	7,107	7,867	284,312	3,984	190,063	254	28,872	1,773	117,364	1,101	45,572	1,147	1,606
July	6,873	7,852	288,241	3,887	177,868	249	31,713	1,750	138,359	1,090	49,621	1,220	1,654
August	6,786	8,092	283,388	4,122	174,031	252	34,576	1,806	159,124	1,089	52,645	1,257	1,695
September	6,822	7,970	278,415	4,070	177,403	276	36,013	1,769	170,423	1,126	57,937	1,045	1,475
October	6,745	7,715	283,011	3,659	181,410	267	34,264	1,741	174,772	1,047	59,343	1,009	1,472
Week Ended:													
11-22-57	6,832	6,632	283,139	3,816	189,390	294	32,942	1,734	169,877	1,015	59,286	915	1,435
11-23-56	7,376	6,923	279,896	3,831	174,544	408	36,305	1,823	158,871	1,208	45,745	891	1,338

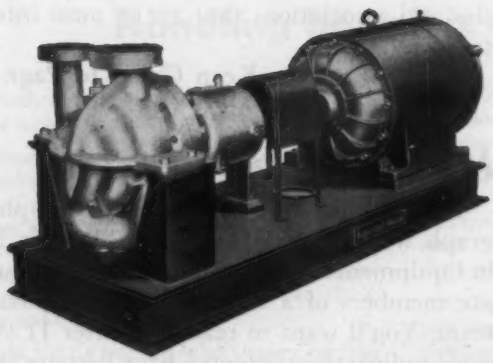
Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

Two-stage Ingersoll-Rand process pumps . . . Class EGT

sizes 1½, 2 and 3 inches . . .
heads to 925 ft. . . .
capacities to 400 gpm . . .
temperatures to 800°F.
hydrostatic pressure tested to 1200 psi
maximum working pressure . . . 600 psi



designed for hot liquids at high heads



The Class EGT pump described here is one of the many models Ingersoll-Rand builds for process applications. This unit is an overhung, two-stage, single-suction, diffusor—volute type pump with oil-ring lubricated ball bearings. Like all other I-R process pumps, it is built in accordance with latest API specifications. Some of the major features that make the EGT a dependable pump with long-range economy are:

Pump pulls apart from back end . . . vertically-split casing design and spacer type coupling permits dismantling for service or inspection without disconnecting piping or driver.

Center Line Support and Casing locating pin . . . centered at the hot-end of the pump casing, prevent pump from moving in any direction except axially due to expansion encountered on high temperature service . . . thus perfect alignment is assured at all times.

Stuffing box . . . is under suction pressure at all times. It is extra deep to allow packing to be arranged to suit the application. Depending upon the service, single or double mechanical seals can be furnished if desired.

If the EGT or any of the many other standard process pumps do not meet your specific requirements, Ingersoll-Rand has the experience and facilities to design and build a pump for your particular application. For further information call or write the nearest I-R branch office.

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COMPRESSORS • TURBO BLOWERS • CONDENSERS • AIR TOOLS • PUMPS • DIESEL AND GAS ENGINES

Building Picture

The lead story in this month's "Who's Building" highlights Celanese Corp. of America's new acrylate ester plant in Pampa, Texas. You'll want to read all about this plant which adds Celanese as the second major source of acrylate esters. There's also dozens of short building capsules which combine to give you a complete picture of who's building what, where in the world.

Keep Going to Page 183

Filter Facts

One of this month's "How To Do It" items tells you an easy way to remove traces of oil and dirt from your hot condensate. There are also a few more hints including one which tells how a refining company uses a pretty girl to take the place of armed guards. You'll want to read all of these so be sure you . . .

Keep Going to Page 177

The Big Picture

In addition to our usual run-down of those items that made the news last month, our section, "What's Happening in the Industry" headlines a story on some of the aspects of petroleum demand—what it has been in the past, and what you can expect from the future. It's interesting, informative, and is packed full of data you'll want to have at your fingertips.

Keep Going to Page 221

I Wonder . . .

Have you ever sat down and wondered what has happened to some of your friends and acquaintances in the industry you haven't heard from in a long, long time? Well here's a bit of advice which will help you. Read "What's Happening Among Men in the Industry"—it's packed with news of the people you went to school with, and those who work around you. All you have to do is . . .

Keep Going to Page 240

Who's Meeting Where?

You'll know after you read PETROLEUM REFINER's "Meeting Calendar"—that easy-to-read tabulation of what's coming up in societies and associations that are of most interest to you.

Keep Going to Page 239

Men from Mars?

Not quite, those two figures in the photograph with the first article of "What's New in Equipment and Manufacturers' Literature," are members of a radiation decontamination team. You'll want to read how after 11 years since radioactivity isotopes have become available commercially, users of these tools in industry have grown to more than 4000. In spite of this, only a few handfuls of people have been trained as radioactive decontamination technicians.

Keep Going to Page 288

This kind of valve service saves money for Cit-Con

Handling hot oil is a cinch for Crane valves

The only manpower needed by these valves is for opening and closing.

Since their installation four years ago on hot oil lines in the Cit-Con Oil Corporation plant in Lake Charles, La., these Crane steel gates haven't cost a cent in maintenance. Handling 630° F. hot oil in heater discharge lines is tough valve service, but these 10-inch Crane No. 33X gates take it in stride.

And that's not the whole story on this Cit-Con unit. Crane No. 159X steel swing check valves on the same hot oil lines have been scot-free of maintenance cost during the seven years they've been in service.

Crane valves give this trouble-free service because of the design experience and manufacturing skill that are built into each valve—and because of the extra care used in assembly and testing.

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Reviewing New Books . . .

"Dangerous Properties of Industrial Materials"

This monumental volume is the successor to Irving Sax's *Handbook of Dangerous Materials*. The immediate and outstanding success of the original book was due to the need for a convenient reference work on the hazardous properties of chemical compounds and other industrial materials to enable chemists, engineers, or non-technical personnel to find quickly whether a given compound or material is potentially dangerous and what precautionary measures must be taken.

This new volume now fills this need. It is a rewritten and expanded version of the original work. The wide experience of the six highly qualified authors gives a thoroughness and dependability so necessary in the vital nature of safety information. It provides a quick single safety reference for those involved in the manufacture, use, handling, storing or shipping of hazardous materials.

(Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 1467 pages, $19.50. Beginning January, $22.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

"Installing Electronic Data Processing Systems"

This new book is by Richard G. Canning. The volume analyzes the impact on the entire organization when a number of systems have been converted to EDP.

The method of organizing an EDP section, selection and training personnel to handle it, probable costs before savings go into effect, proparations for computer site and programs, operation during the conversion period, and avoidance of fraud and error are among the many problems facing every company in the process of installation. The fields on which the author has drawn include insurance, aircraft and petroleum production, home appliance manufacture, transportation, banking, and military activities.

(John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 193 pages, $6.00.)

ASTM Standards on Electrical Insulation

This book contains extensive revisions and new standards to keep the contents abreast of current industrial developments. It provides an up-to-date and handy compilation of ASTM test procedures and specifications for electrical insulation for use of manufacturers of equipment and those associated with the use and distribution of electrical power. The test methods are widely used for evaluation of potential new or improved insulating materials and for related research and development investigations. The specifications provide the consumer with a basis for purchase of insulating materials of known quality.

Also included is a suggested liquid displacement method for dielectric constant and dissipation factor of polyethylene.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 692 pages, $6.00.)

Symposium on Vapor Phase Oxidation of Gasoline

Presented at the Second Pacific Area National Meeting, September, 1956, in Los Angeles, under the sponsorship of Committee D-2 on Petroleum, this Symposium contains the following papers:

"Introduction," by William R. Power, John M. Campbell, and R. C. Allen.

"Fuel Factors Influencing Deposits in Intake Portion of Fuel System of Gasoline Engines," by H. J. Scheule.

"Induction System Gum—Engine Versus Bench Test," by J. L. Keller and F. S. Liggett.

"Test Method for Studying the Effect of Fuel Composition upon Intake Valve Deposit Forming Characteristics," by A. V. Cabal and J. Capowski.

"Effects of Inhibition and Environment on the Induction System Oxidation of Gasoline," by A. C. Nixon, H. B. Minor and T. P. Rudy.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 68 pages, $2.50.)

ASTM Viscosity Tables

The tables in this booklet provide a convenient means for viscosity conversions and for obtaining basic values for calculation of viscosity index.

The tables are based on the adoption of 1.0038 cs at 68 F as the standard value for the kinematic viscosity of water on July 1, 1953. This resulted in a reduction of 0.318 percent in the kinematic viscosity of a given product.

The tables include:

Conversion of Kinematic Viscosity to Saybolt Universal Viscosity.

Conversion of Kinematic Viscosity to Saybolt Furol Viscosity.

Basic Values for Calculating Viscosity Index from Kinematic Viscosity.

Values for Calculating Viscosity Index from Saybolt Universal Viscosity.

Factors for Converting Kinematic Viscosity to Saybolt Universal Viscosity at Temperatures from —100 to +500 F.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 65 pages, $2.00.)

Engineering Data Book

The seventh edition of the Engineering Data Book, published by the Natural Gasoline Supply Men's Association, is being released for distribution. Featuring a new section containing the revised NGAA Equilibrium Ratio (K Value) charts, the new edition is a complete manual for the design and operation of natural gas processing plants.

Other new or expanded sections in the new edition include up-to-date data on: gas measurement; water treating; cooling towers; storage; gas, gasoline, and LPG treating; piping; fluid flow; compressors; and electrical equipment.

(Obtainable from any NGSMA member company or from the Association offices, 421 Kennedy Building, Tulsa, Oklahoma, 320 pages).

American Drafting Standards Manual Y14

Uniform drafting practices throughout American industry and the engineering professions has been accomplished with the approval by the American Standards Association of four sections of the American Drafting Standards Manual Y14 and their publication by The American Society of Mechanical Engineers.

By using these new standards, engineers in industry and government can avoid costly misunderstandings, errors and delays in interpreting engineering drawings.

The project is sponsored jointly by The American Society of Mechanical Engineers and the American Society for Engineering Education to meet the need of American industry and government services for uniform drafting practices. These two organizations have been leaders of the project since 1948. Work in this field was started in 1925.

The first four sections of the American Drafting Standards Manual Y14 approved as American Standards are: Section 1, Size and Format; Section 2, Line Conventions, Sectioning and Lettering; Section 4, Pictorial Drawings; and Section 5, Dimensioning and Notes.

Twenty-three national organizations, including U. S. military departments, participated in the work. They represent all industrial, trade, professional and governmental groups vitally concerned with the scope and application of the standard.

(The American Society of Mechanical Engineers, 29 West 39 Street, New York 18, or the American Standards Association, 70 East 45 Street, New York 17: Section 1, Y14.1—$1.00; Section 2, Y14.2—$1.50; Section 4, Y14.4—$1.50; Section 5, Y14.5—$2.00.)

National Fire Code

The National Fire Codes, a compilation of 168 fire safety standards as developed by the National Fire Protection Association, have just been published by the NFPA in a revised six-volume 1957 edition.

The six new volumes by title and content are:

Volume I—Flammable Liquids and Gases (35 standards, 896 pages).

Volume II—Combustible Solids, Dusts, Chemicals and Explosives (34 standards, 624 pages).

Volume III—Building Construction and Equipment (31 standards, plus an informative discussion of building codes and references to model codes, 736 pages).

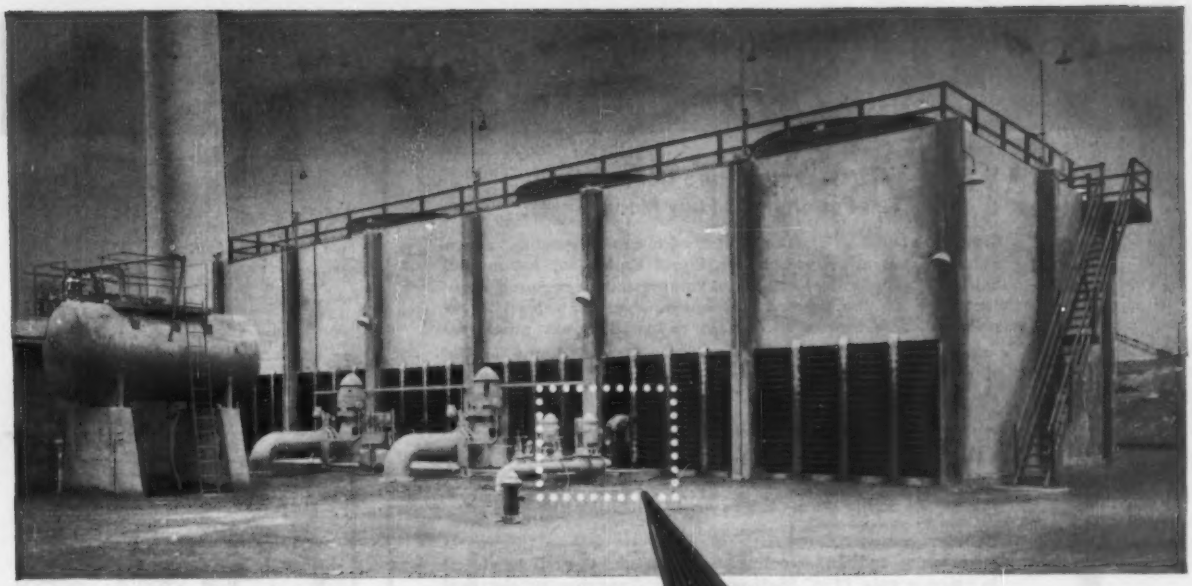
Volume IV—Extinguishing Equipment (33 standards, 1088 pages).

Volume V—Electrical (The National Electrical Code, 1956 edition, including interpretations and interim amendments to July 30, 1957, plus six other NFPA electrical standards and a digest of the electrical provisions of 69 other NFPA standards, 704 pages).

Volume VI—Transportation and Misc. (28 standards on air, marine, bus and truck transportation and salvage, plus a comprehensive review of applicable government regulations, 672 pages).

More than 100 technical committees composed of experts representing the general public, government, industry, and insurance prepare and regularly review and revise all NFPA fire safety standards.

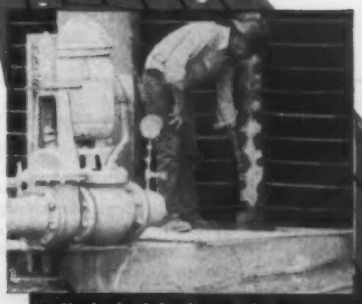
(Publications Department, National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass., $6.00 per volume).



Unusual Cooling Tower

gets proven *Nalco* protection

This unusual cooling tower was built for the Riverside Cement Company at Oro Grande, California. The advanced design provides for concrete exterior walls which support and enclose fan units and redwood interior cooling vanes . . . The entire "working sections" of the tower can be repaired or replaced without affecting the structural strength of the shell. Nalco System Treatment protects this cooling system against scale and corrosion — has protected it effectively since it was first put in operation over two years ago. You can get the same complete water treatment protection, promptly, from Nalco. Write for details.



Method of feeding Nalco stabilizing treatment to this system is simplicity itself. Formula is supplied in ball form. Once each shift a perforated tube suspended in the tower basin is filled with balls which slowly dissolve in the cooling water.

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THE *Nalco*® SYSTEM . . . SERVING INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

For more data on advertised products, use Readers' Service Cards, last page.

Low-cost Temperature Control — by SARCO

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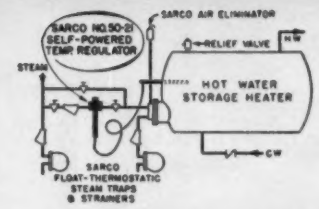
Simple as ABC . . . a thermostat with capillary tubing and a valve. That's all! Operated by liquid expansion. Automatic. Self-powered . . . no electricity or compressed air required. Self-contained . . . no exposed mechanism. Packless valve . . . no stuffing box to leak or stick. Easy to install by any pipefitter.

Furnished with thermostats suitable for any liquid or for air in dryers, ovens, air ducts, etc. Valve sizes . . . ½ to 6". Temperature ranges to 300°F. *Bulletin 620-2.*



Typical applications: Shell and tube heat exchangers; condensers, oil storage tanks, dryers, etc.

Sarco Cooling Controls
Self-Powered . . . Fully Modulating

Simple, compact, automatic thermostatic valve. Eliminates overcooling and undercooling. Saves water. Overall height of ¾" size is only 17⅛". Self-powered . . . requires no electrical or compressed air hook-up. Valve and bulb all in one unit. No exposed mechanism. Single-seated packless valve . . . not affected by silt or scale-forming minerals.

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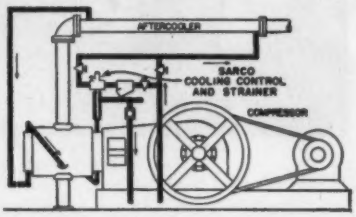
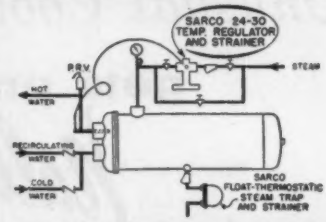


Typical applications: compressors, small engines, water-cooled bearings, condensers, dry cleaning stills, etc.

Sarco Temperature Controllers
Self-Powered . . . Single-Seated, Tight-Closing

A simple, self-powered automatic temperature controller with diaphragm-operated, pilot-controlled valve. Designed for intermittent service or service involving long periods with practically no call for steam. Self-powered by liquid expansion . . . no electricity or compressed air needed. Packless.

Valve sizes . . . ½ to 3". Temperature ranges to 300°F. *Bulletin No. 625-B.*

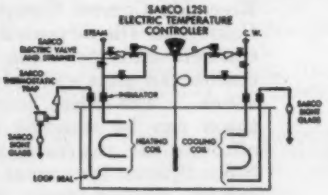


Typical applications: Instantaneous heaters, fuel oil pre-heaters, high pressure applications on hot water storage tanks.

Sarco Electric Temperature Controllers
Indicating Type

Simple, inexpensive, electric-indicating automatic temperature controller. Sensitive enough to perform many of the functions of much more elaborate recorder-controllers, at a fraction of their cost. Responds to changes of ± ½°F. Adjustable. Large, easy-to-read scale shows both actual and set temperatures.

Temperature ranges between minus 90° and plus 650°F. Offers many sequence combinations such as step-heating. *Bulletin 1025-B.*



Typical applications: plating tanks, processing vats, kettles, chemical tanks, etc.

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For remote control by hand or thermostat. Open and shut operation. Can be equipped with semi-modulating mechanism. Powerful hydraulic action operates valves up to 5" single-seated, or 8" double-seated, at pressures up to 175 psi. Ruggedly constructed . . . to withstand severe use without constant supervision and with minimum maintenance. Operates in any position.

For direct connection to 110 volts A. C., 60 cycle current. Valve sizes . . . ½ to 5" single-seated; ½ to 6" double-seated. *Bulletin 1080-A.*

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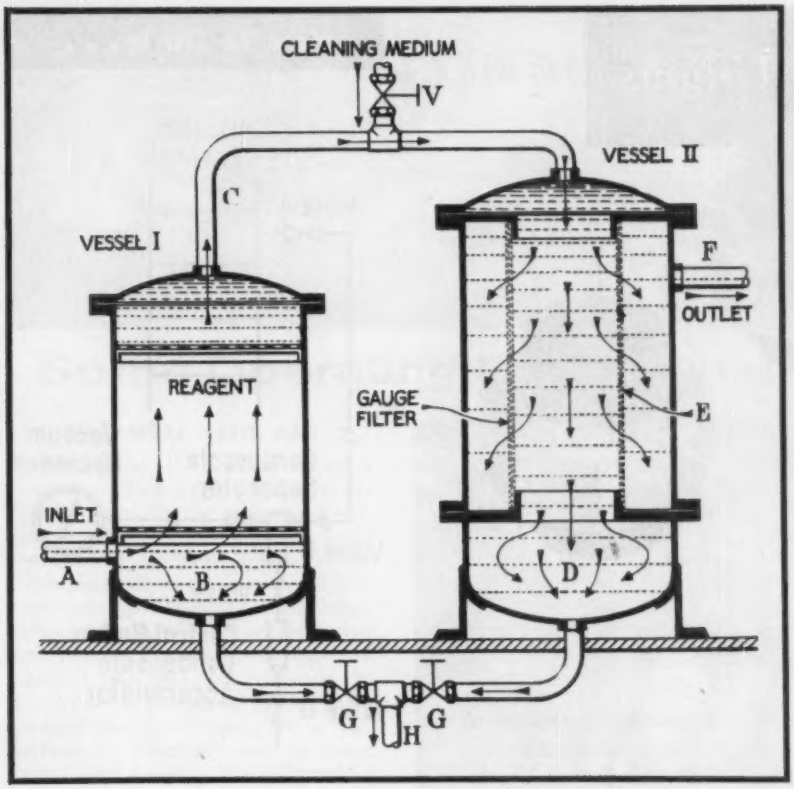


How To Do It . . .

This Filter Plant Cleans Condensate

Here's an easy way to remove oil traces and dirt from your hot condensate.

Hot condensate, which was ultimately piped into the hotwell of an auxiliary steam boiler, required cleaning from traces of oil and from small mechanical impurities. We adapted two vertical cylindrical vessels to act as chemical reaction vessel and as a filter vessel in the following way. Vessel 1 had two perforated plates fitted, one near top and one near bottom of the cylinder, supported by welded-in rings, as shown. An inlet opening A was cut, and openings B and C provided for. The chemical reagent (activated carbon) was packed loosely between the two perforated plates.

The second and larger vessel was adapted as shown to filter the liquor coming from the first vessel via the top opening. All mechanical impurities had to pass through cylinder E, consisting of 12 to 20 layers of bronze gauze metal wound round the upper and lower cylindrical support. Impurities collected in sump D. Clean water left at outet F.

For periodical cleaning, the cleaning liquor, a water-soda mixture was admitted via cock IV, after the chemical and filtering action was stopped. Cocks G were opened, and the cleaning solution drained via outlet H. All impurities from sumps B and D were flushed away.

After longer periods, the plant received a general overhaul. The covers from both vessels were removed, and the reagent in vessel I renewed. Gauge filter cyinder of vessel II was mechanically cleaned with a brush.

Idea submitted by:
Leo Walter
Gloucester, England

Look How You Can Drain Vacuum Instrument Lines

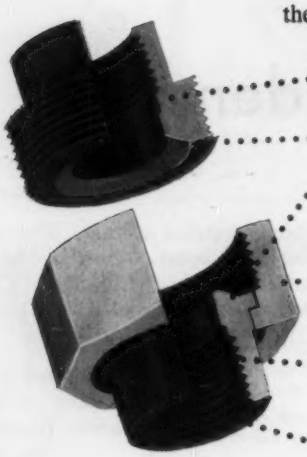
In vacuum distillation units, vacuum recorders and vacuum gages are generally used to measure the pressures at various points in the vacuum tower.

The condensates of stripping steam and oil vapors are often condensed in the small instrument lines leading from the vacuum tower to the recorder. Separators are installed on

W-S Forged Steel Unions

. . . these features tell the difference . . .

Not all forged steel fittings are alike. Careful design and precision manufacture give W-S Forged Steel Unions these important features that tell the difference:



1. Designed to AAR dimensional specifications.
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3. Cadmium plated nuts for resistance to corrosion and to galling and siezing.
4. End pieces protected against rust by new W-S blue synthetic coating.
5. Octagonal end pieces for better gripping.

W-S Unions are machined from forged steel in accordance with ASTM material specifications A-105, Grade 2. They are available with screw-end and socket-welding end pieces in 3000 lb. class, sizes ⅛" to 3".

For complete information send for Bulletin U-1. Write to W-S Fittings Division, H. K. Porter Company, Inc., P. O. Box 95, Roselle, N. J.

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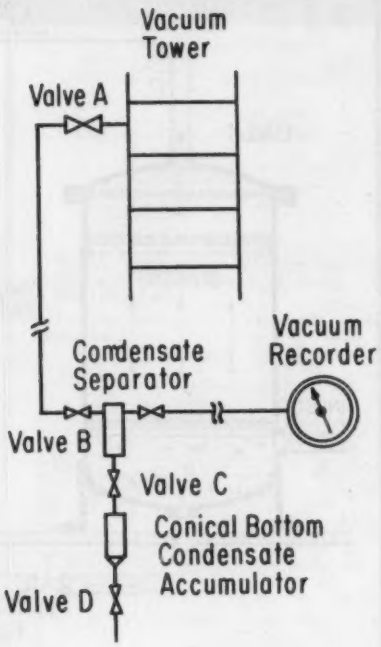
W-S FITTINGS DIVISION

How to Do It . . .



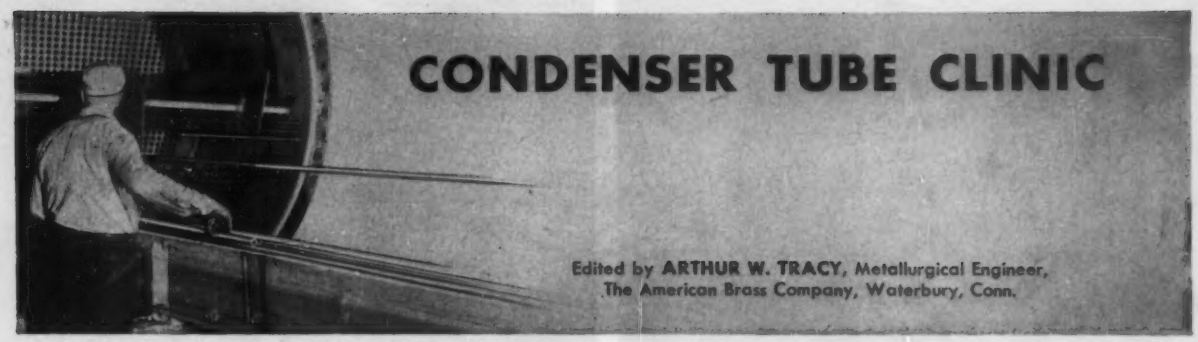
the lines located at convenient places for drainage purposes.

Before draining, the valve between the tower and separator is closed. The drain valve is opened, air is sucked into the separator as well as the small instrument line, and the condensate drained out of the separator. After drainage is complete, the drain valve is closed and the valve between the tower and separator is opened. This operation causes the instrument to be out of use for five minutes or longer.

The figure shows an improved installation to drain the condensates from vacuum to atmospheric pressure without interfering with the vacuum recorder. Below the separator, a conical bottomed vessel, four inches in diameter and ten inches long is attached. During the distillation procedure, valve D is closed with all other

YOUR IDEAS ARE VALUABLE!

At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.



CONDENSER TUBE CLINIC

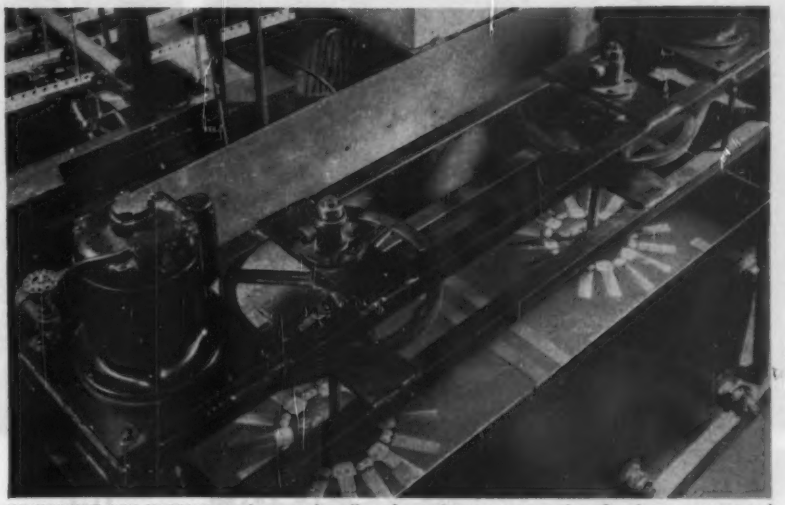
Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Conn.

Some Operating Factors that affect tube life

OXYGEN AND AIR

Oxygen in the air in cooling waters is a necessary factor for corrosion to occur, but normally the presence of oxygen in solution does not cause rapid corrosion of condenser tubes. On the other hand, air in the form of bubbles can cause rapid corrosion of condenser tubes under conditions where turbulent flow is present. Air bubbles of harmful size may be produced by whirlpools in the intake tunnel, leaky packing glands on pumps, and at projections in injection pipes or water boxes. Any condition that will produce a negative pressure at some point along a tube, such as a long outlet water leg from a condenser, can also cause air bubbles to form with consequent local rapid pitting.

Sea-chest strainers may be another source of air bubbles unless designed to allow nonturbulent flow of water.



EQUIPMENT FOR TESTING condenser tube alloys for resistance to corrosion. Specimens are rotated under water to determine the effect of velocity. Further information is obtained by testing actual condenser tubes in operating condensers.

STRESSES

Stresses capable of causing stress-corrosion cracking of some alloys can be set up in tubes by thermal expansion pressure or from the rolling-in of tubes into tube sheet. It is not usually possible to change operating conditions to reduce stresses, but failures from stress-corrosion cracking can be minimized by the careful rolling-in of tubes to avoid developing high longitudinal stresses, especially when both ends of the tubes are expanded into the tube sheets.

Cyclic stresses due to vibration can cause fatigue failure of condenser tubes, and such a failure can be extremely rapid even when only tiny corrosion pits have developed on the wall of the tube. If the source of the vibration cannot be removed, the vibration of the tubes can sometimes be dampened.

GALVANIC EFFECTS

The galvanic corrosion of condenser tubes is seldom a problem because the choice of metals is usually such that the tubes are galvanically positive (cathodic) to the tube sheets and the water boxes. Any slight galvanic corrosion on tube sheets and water boxes due to their being anodic to the tubes is insignificant because of their relatively great thickness.

Zinc or magnesium sacrificial anodes are frequently placed in condenser water boxes that have been treated with paint or an organic coating to protect the iron or steel from accelerated corrosion at "holidays" or pinholes in the coating. Such anodes will generally protect the ends of the tubes from corrosion for a short distance, usually equivalent to about two tube diameters.

There is considerable experience indicating that bare iron or steel water boxes not only act as sacrificial anodes in protecting the ends of condenser tubes, but also that the corrosion products from these water boxes mixing with the tube corrosion products help build a more protective film along the whole length of the tube. Iron anodes in painted water boxes will be a source of iron compounds but will have little effect in galvanically protecting water boxes at the discontinuities in the paint film. When a new set of tubes is started in service in an old condenser where surfaces are well scaled, the use of new, clean iron anodes should aid in a more rapid formation of protective film on the tubes.

TECHNICAL HELP IN SELECTING TUBES

Your situation may require special consideration and analysis. We are always ready to help and advise in the selection of the right alloy to give best service. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 8787

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for Condensers and Heat Exchangers

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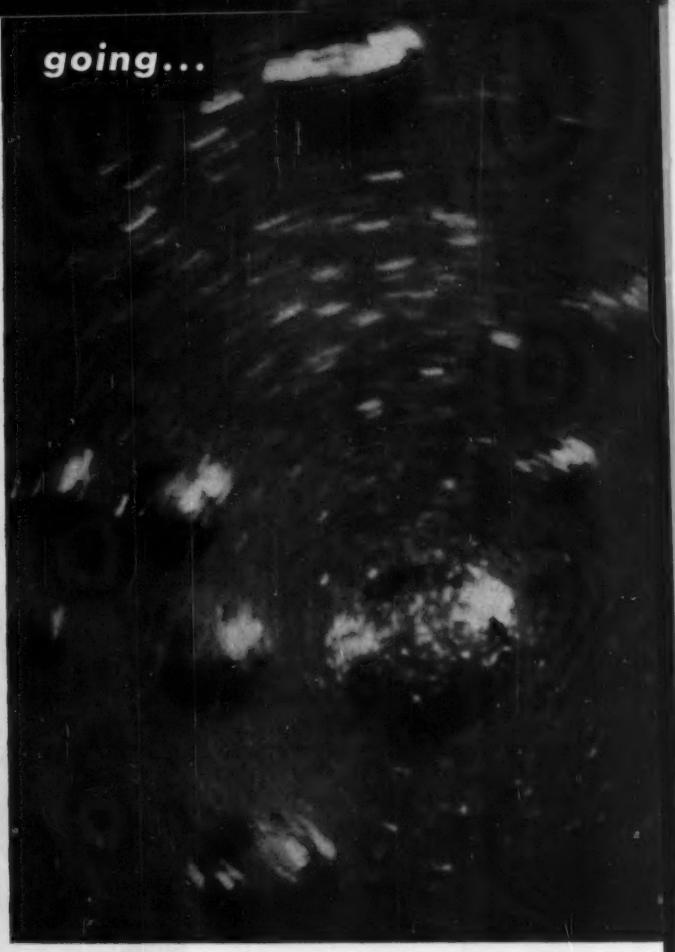

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These dramatic microphotographs show how a single flake of Dalpac 4 antioxidant is speedily dissolved into the gasoline stream.

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Dalpac 4 type inhibitor meets military specifications for aviation gasoline and jet fuel. It prevents decomposition and sludging in turbine oils. It retards sludge and peroxide formation in transformer oils without changing their electrical properties.

You will find Dalpac 4 also effective in petroleum waxes, brake fluids, hydraulic oils, slushing oils, cutting oils—almost any petroleum product where resistance to oxidation is desired.

Dalpac 4 is shipped from Gibbstown, New Jersey and Hattiesburg, Mississippi, and is available in solid and liquid forms. This antioxidant is made from Hercules' own basic source, para-cresol. Buying Dalpac 4 from Hercules is your assurance of both supply and top quality. **Hercules Trademark*

Oxychemicals Division Naval Stores Department

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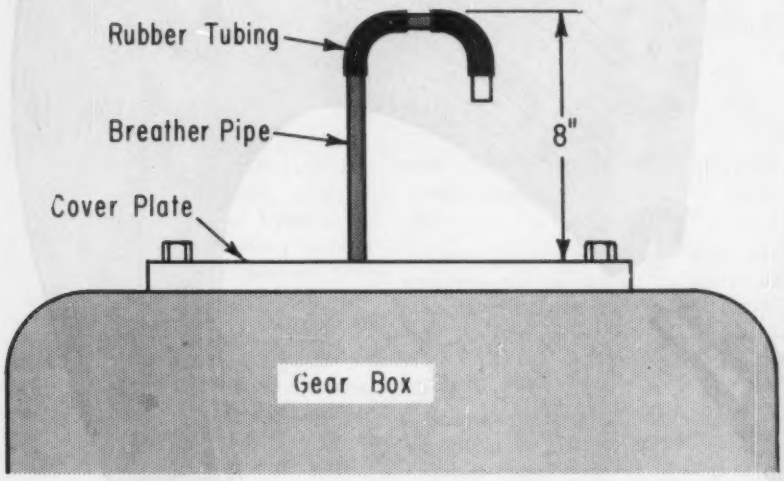
N057-B

valves open. The condensates will accumulate in the vessel. To drain, close valve C and open Valve D. The condensate in the vessel will be drained to the atmosphere. Then, close D and open C, repeating the process if necessary.

This idea can also be applied to the safe sampling of hot oil from high pressure vessels.

Idea submitted by Y. N. Fan, Berkeley, Calif.



How to Do It . . .

Gear Box Breather Keeps Water from Lube

Pump reduction gear boxes have breathers on top. When these boxes are exposed to the atmosphere, water often enters the box through the breather and contaminates the lubricant. This, of course, necessitates an excessive number of oil changes.

By installing a simple, piping breather system in the form of a "U", on the gear boxes, water is eliminated as a lubricant contaminant and the lubrication requirement on these pumps can be reduced by as much as one third.

Idea submitted by:
K. D. Prestenbach
Ethyl Corp.
Pasadena, Texas

Pretty Girl Does Work of Armed Guard

Suntide Refining Co., Corpus Christi, Texas uses a pretty girl instead of armed guards to attend its entrance gate.

When a visitor calls on someone at the refinery, he merely asks the operator to connect him with that person through a phone conveniently located outside the entrance building. When the visitor completes the appointment, the pretty gate-attendant-switchboard operator presses a button, opening the motor-operated gate, and our visitor is on his way.

Idea submitted by Harry A. Hess, Houston.

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Superior quality forged body —precision machined
Uniform wall thickness —no weak spots
Extra heavy reinforcing rim
Larger diameter cam ears for longer service life
Extra Hi-Strength forged handles —greater economy
Stainless Steel pins —greater safety and longer service
Uniform heavy wall thickness —no weak spots
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In every field of high-pressure seal—for pipe flanges, pressure vessels, and process equipment—engineers know and recognize Flexitallic Spiral-Wound Gaskets. The blue dye in the Canadian asbestos filler provides positive product identification.

Flexitallic Blue tells the user that the gasket is made by an engineering organization devoted exclusively to the manufacture of Spiral-Wound Gaskets since 1912.

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Who's Building . . .

Help for Increasing Acrylate Demands

Celanese Corp.'s new Pampa, Texas plant becomes second major source.

Celanese Corp. of America has started operation in Pampa, Texas of a new 15 million pound-a-year acrylate ester plant, thus marking another step in its chemical expansion program. The company has begun tank car shipments of the chemical from Pampa.

The new facilities will add Celanese as a second major source of acrylate esters, a rapidly growing family of petrochemicals used in the paint, leather, textile, paper and other industries.

This production will mark the first use of a new method for making acrylate esters discovered by B. F. Goodrich Co. The process at Pampa, developed by Celanese from basic Goodrich findings, utilizes acetic acid and formaldehyde, and is reported to be more economical than other processes. Celanese makes both acetic acid and formaldehyde at its Bishop, Texas plant.

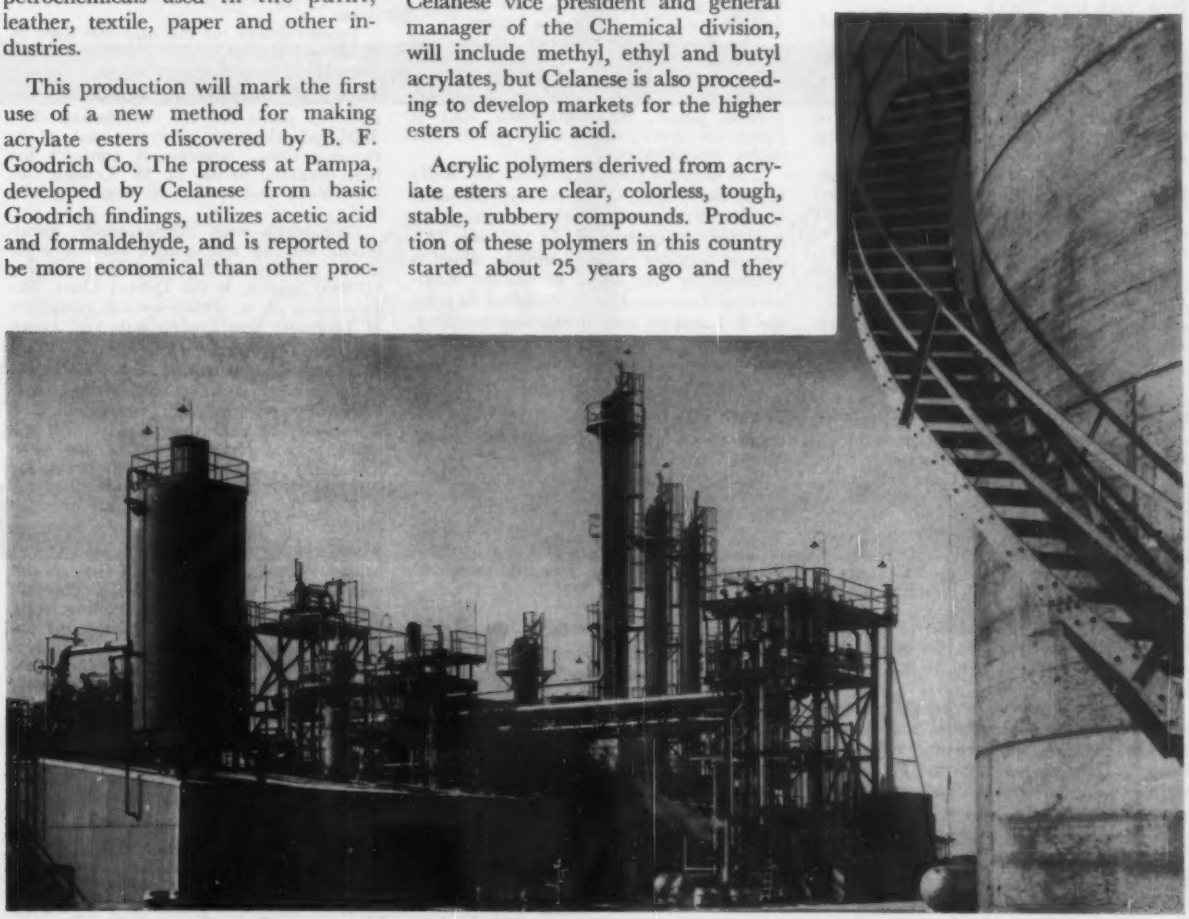
Owing in large measure to the increasing use of acrylic polymers in water-thinned latex paint, consumption of acryate esters has doubled since 1954 and is expected to double again by 1960.

Immediate production at Pampa, according to Rihard W. KixMiller, Celanese vice president and general manager of the Chemical division, will include methyl, ethyl and butyl acrylates, but Celanese is also proceeding to develop markets for the higher esters of acrylic acid.

Acrylic polymers derived from acrylate esters are clear, colorless, tough, stable, rubbery compounds. Production of these polymers in this country started about 25 years ago and they were first used commercially in leather finishing and as an interlayer for laminated safety glass. Their consumption increased during World War II, and accelerated as they began to be used in water-thinned paints about three years ago.

Plan Engineering Center

Plans have been announced for a new $10 million United Engineering Center to be erected on United Na-



Celanese Corp. of America's new plant at Pampa, Texas, makes the company a major supplier of acrylate esters.

New engineering building to be finished and ready for occupancy by 1960.

tions Plaza between 47th and 48th Streets, New York City.

The new building will serve as the headquarters of 16 national engineering societies with a membership of about 250,000.

The new building will replace the present Engineering Societies building which is now inadequate in view of the growth of technology since the building was first occupied 50 years ago.

Announcement of the plans was made by Dr. Mervin J. Kelly, president of Bell Telephone Laboratories, who is serving as chairman of the industrial campaign to raise funds for the new engineering center.

Present plans call for the occupancy of the building in the fall of 1960. It will be a 20-story tower surrounded by lower structures with landscaped grounds. The center will not only have adequate facilities for present functions, but provision will be made for continuing growth.

The Engineering Societies Library will be included, and there will also be exhibition space in which the rapid advances in engineering will be interpreted for the general public. An engineering Hall of Fame for distinguished engineers is also under consideration.

The industry campaign which Dr. Kelly heads has a goal of $5 million. Members of the various engineering societies are expected to contribute $3 million. This money, together with $2 million which is available in the assets of United Engineering Trustees, Inc., is expected to meet the $10 million cost of the new building.

Maruzen Oil Co., Ltd., has placed on stream at its Matsuyma, Japan refinery, the sixth of 11 UOP Platforming units licensed to Japanese petroleum refiners.

With a design capacity of 3000-bpd, the Platformer is designed to produce a 95 F-1 leaded octane blending component from naphtha derived from Middle East crude. Platformate will be used to upgrade the refinery's regular and premium grades of gasoline.

In addition to construction of the new facility, the capacity of the crude unit was increased and erection of a 1500-bpd Udex unit was begun.

The Udex unit will be integrated with the Platformer to produce high purity benzene, toluene and xylenes. When the Udex unit is on stream, the Platformer will be operated on a blocked-out basis to produce, alternately, motor fuel blending component and Udex charge.

Design and engineering of the Platforming and Udex units was handled by Universal Oil Products Co., Des Plaines, Ill., in conjunction with the Japan Gasoline Co., which licensed the units.

Brazil may get a new 20,000 bpd refinery which has been proposed for central Minas Gerais state.

Brazil will continue to export high-paraffin fuel oil which cannot be consumed domestically for some time. Authorization for the export of 50,000 tons of fuel oil to Uruguay, and 50,000 tons to Western Europe, has recently been effected.

Compagnie Francaise de Raffinage, Provence, France, is building one of the highest heat capacity vertical tubular heaters in the world to supply the feed preheat requirements for the 20,000-bpd Powerformer being built by Foster Wheeler. With the exception of the heater, the unit is a duplicate of the Powerformer recently completed by Foster Wheeler for Esso Standard Oil Co.'s Bayway, N. J. refinery.

The heater, which has a vertical radiant section and a horizontal convection section has a heat absorption capacity of 176 million BTU per hour. Its radiant section is 41 feet in diameter and 71 feet high.

Who's Building...

Caltex S. A. F., French affiliate of California Texas Oil Co., Ltd., has placed on stream at Bec d' Ambes, France, a UOP fluid catalytic cracking unit.

The cat cracker has a design capacity of 5150 bpd. It is processing atmospheric and vacuum gas oils derived from Middle East crudes. Universal Oil Products Co., Des Plaines, Ill., provided process designs and licensed the unit. Detailed engineering and construction were handled by French contractors.

The California Oil Co. has awarded a contract to the H. K. Ferguson Co. for construction of a new two-stage catalytic reformer at its Perth Amboy, N. J. refinery. Contract provisions call for Ferguson to provide engineering design, procurement of materials, and erection of the 10,000-bpd unit.

Construction of the new refinery facility is expected to get under way next Spring, with completion scheduled for the first of 1959.

Operating on a feed stock of straight-run naphthas and heavy cracked naphthas, the two steps involved in the process include a first stage in which the feed to the second stage is desulfurized, and unsaturates are hydrogenated. The second stage then catalytically reforms the naphthas to a high quality gasoline suitable for blending in finished motor gasolines.

Process design for this unit was done by California Research Corp. under a license from Universal Oil Products Co.

The Bay Petroleum Corp. has announced plans for the installation of a 3500-bpd catalytic reformer unit at its Denver, Colo., refinery. A contract has been awarded to the M. W. Kellogg Co., New York and work will begin immediately.

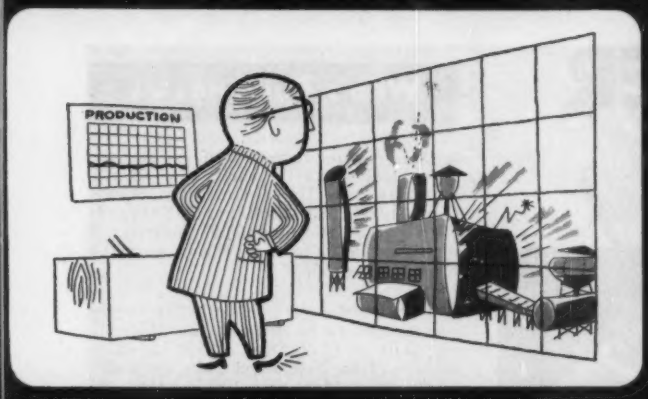
Coincident with the reformer installation will be the construction of additional gasoline storage facilities, totaling 100,000 barrels, at the Denver plant. Bay Petroleum is a wholly-owned subsidiary of Tennessee Gas Transmission Co., Houston.

Monsanto Chemical Co. will construct a urea plant at El Dorado, Ark. Construction of the plant, which will have a capacity of 100 tons a day, will get under way before the end of the year. The plant is expected to be on stream by early fall of 1958. The new facility will produce urea in both prill and solution forms.

Badger Manufacturing Co., Cambridge, Mass., has received its second contract this year for an MEK (Methyl Ethyl Ketone) dewaxing-deoiling unit. The first contract was awarded by the Atlantic Refining Co. The more recent job, including vacuum distillation facilities, was ordered for Sinclair Refining Co.'s East Chicago, Indiana, refinery.

The Sinclair plant is expected to be on stream late in 1958 while the Atlantic unit will not be complete before early 1959. When operating, both units will produce high-grade products.

Commercial Solvents Corp. has placed on stream its expanded synthetic methanol purification facilities at Sterlington, La. The job was engineered by Badger Manufacturing Co., Cambridge, Mass., using Badger's new process for producing extra high purity methanol and is



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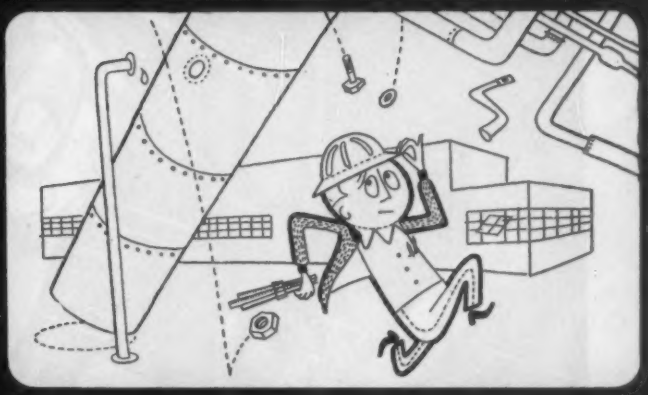

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Who's Building . . .

the first of three current methanol projects being handled by the engineering firm to go on stream. The unit, which substantially increases Commercial Solvents Corp.'s synthetic methanol facilities, is the second to be built for this company by Badger since 1952.

Procon, Inc., is erecting the largest heaters ever to be designed for Platforming units at Gulf Oil Co.'s Philadelphia refinery. Two 26,000-bpd units are under construction. More than 100 feet long, the installations will each handle two intermediate stages. Procon engineers recommended single heaters for each Platforming unit instead of two smaller heaters for best use of available space and maximum construction and piping economy. The Platforming units are the second and third to be built at the refinery, and are expected to go on stream early next year.

Creole Petroleum Corp. has announced completion at its Amuay refinery in Venezuela of a new crude oil distillation plant, with a capacity of 104,000 barrels daily. It is the fourth such distillation plant to be built at the refinery and brings its total capacity to 328,000 bpd.

As in the case of its predecessor plant, No. 3 Pipe Still No. 4 will be operated by Venezuelan employees trained to take charge of installation. The new refinery unit will mainly process heavy crude from Creole's Bachaquero field for the production of light naphtha and fuel oil.

Construction of the fourth distillation plant was carried out by the Foster Wheeler Corp.

Esso Nederland N.V. has announced that agreement has been reached between the Netherlands Government and Standard Oil Co. (New Jersey), on the increase of capacity of the Rotterdam refinery, to be constructed in the Botlek area near Rotterdam. Capacity will be increased from 14 million to 31.5 million barrels per year.

Badger-Comprimo N.V. at The Hague, subsidiary of Badger Manufacturing Co., Cambridge, Mass., has been awarded the prime contract for mechanical engineering and field construction in accordance with process design by Esso Research and Engineering Co., New York. The Engineering and Architectural Office Ir. J. P. van Bruggen, G. Drexhage, Ir. J. J. Sterkenberg, A. Boden at Rotterdam will act as architects and advisers for the construction of the administrative building and the workshops.

Construction of the refinery will involve an amount of $50 million. Construction will be started in 1958 and the expanded facilities are expected to be on stream early in 1960.

British Petroleum Co. will invest about $170 million by 1965 to maintain its 16 percent of West Germany's growing refining industry. The investments planned include:

About $83 million for its projected 80,000 bpd refinery in the Ruhr.

About $28.5 million for its half-interest in a new plant for processing olefins, now under construction near Cologne. The other half-interest is owned by Bayer.

About $12 million for its share in the

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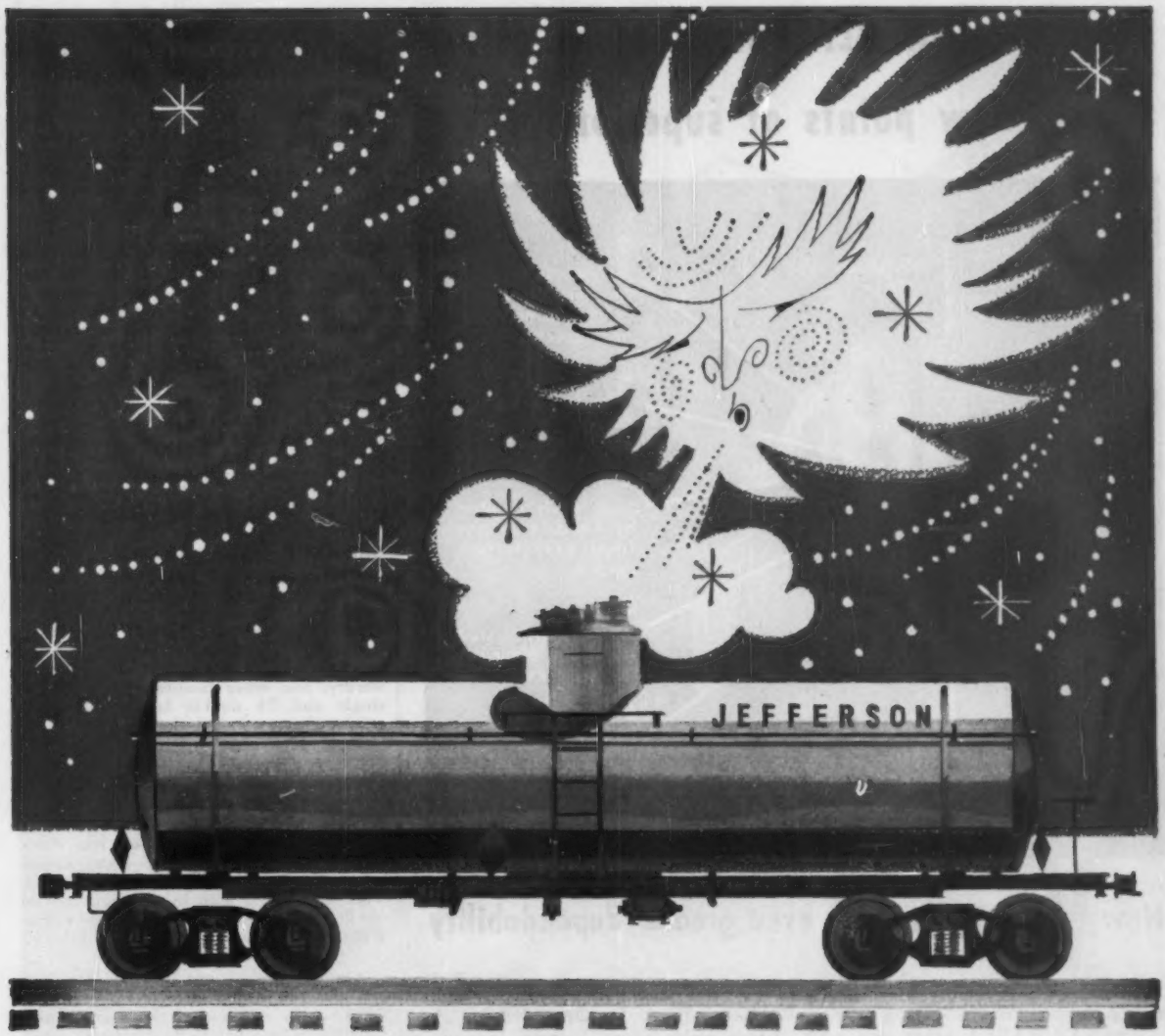

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. . . then why not solve it by simply contacting your nearest Jefferson office? Our know-how on tank car and drum thawing techniques should reduce your difficulties to a simple handling routine.

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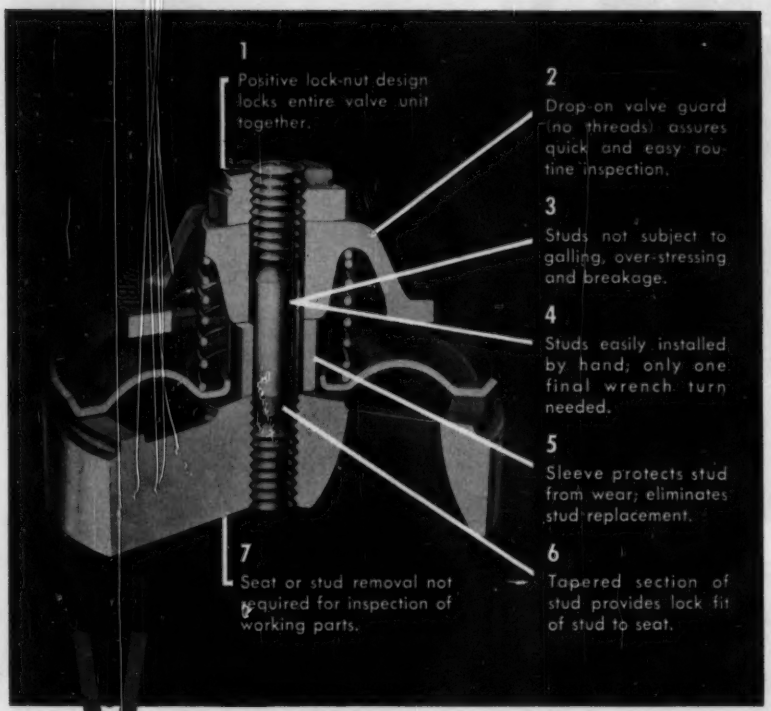
Now...DURABLA Pump Valves offer 7 new points of superiority!


1
Positive lock-nut design locks entire valve unit together.
2
Drop-on valve guard (no threads) assures quick and easy routine inspection.
3
Studs not subject to galling, over-stressing and breakage.
4
Studs easily installed by hand; only one final wrench turn needed.
5
Sleeve protects stud from wear; eliminates stud replacement.
6
Tapered section of stud provides lock fit of stud to seat.
7
Seat or stud removal not required for inspection of working parts.

New V-design assures even greater dependability

You want *maximum valve dependability* for your reciprocating pumps . . . and DURABLA gives you just that in the new V-7 unit.

Incorporating seven points of superiority, the new valve features a tapered or V-shaped stud which screws down tight to the seat. This exclusive design anchors the stud, eliminating any possibility of galling, over-stressing or breakage. What's more, the new self-locking nut and drop-on guard assure quick and easy inspection of working parts—without stud or seat removal.

Remember: In the DURABLA Valve, only "point contact" is made by the valve member on the stud sleeve, so it can't bind or hang-up. The open-type guard assures free flow of liquid, prevents clogging.

These stainless-steel valves operate freely under temperature extremes, with corrosives, and in any position. Made in 15 sizes to fit any reciprocating pump, old or new.

Send for *NEW* 8-page booklet PR-127.

Keep your pumps fit with the valves that fit all pumps.

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DM-26

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Who's Building...

construction of the planned pipe line from Wilhelmshaven to the Ruhr refining area.

About $5.5 million for expansion of present refinery installations at Hamburg.

About $38 million for expansion of storage and distribution facilities.

California Ammonia Co., Lathrop, Calif., has announced plans for the construction of a 100 ton a day anhydrous ammonia plant. The facility will cost approximately $4.8 million and is expected to be completed in October, 1958.

California Ammonia is a joint venture between farmer consumers and industry to secure ammonia at cost. This combination assures a captive market for the entire production of the plant and, at the same time, provides experienced chemical plant management. Over 540 California farmers have subscribed in order to reduce their fertilizer costs.

Sun Oil Co. has dedicated its new $2.5 million research and development laboratories located near its Marcus Hook, Pa., refinery.

Sun's research is primarily directed in the fields of physics, chemistry, biology, and catalysis. In addition to offices, shops, library, and other facilities, there are 39 single and 24 double laboratories comprising the new installation.

Basic petroleum and product research, petrochemicals, and fuels testing are among the many endeavors being pursued at the new laboratories.

Monsanto Chemical Co. has completed at Luling, La., a major expansion in production capacity for adipic acid. This chemical is used in the manufacture of flexible and rigid foamed resin materials, vinyl plastics, synthetic lubricants and nylon.

The new unit is integrated to raw materials facilities of the former Lion Oil Co., marking the first such integration of new production facilities to be completed since the September, 1955, merger of Monsanto and Lion.

Long used in the manufacture of nylon, adipic acid has come into expanding use in the manufacture of urethane foams.

The reactive dibasic acid also is used to make adipate plasticizers which give flexibility to polyvinyl chloride resins, and to improve the flexibility of polyesters.

Government of Iraq Oil Refineries Administration has authorized Foster Wheeler Ltd. London, England to design and construct process facilities at the Daura, Bagdad refinery for expansion and modification of existing combination unit, which will increase its capacity from 24,000 to 48,000 bpd. The company will also build a 5000-bpd Powerforming unit, a 5000-bpd kerosene treating unit, and substantial offsite facilities.

Foster Wheeler recently completed for the Iraq Government a complete lubricating oil manufacturing plant.

Rock Island Refining Corp. has placed on stream the second Unifining unit at its refinery near Indianapolis.

Like an earlier Unifining unit and a Platforming unit, the latter completed in 1954, the new unit has electronic con-

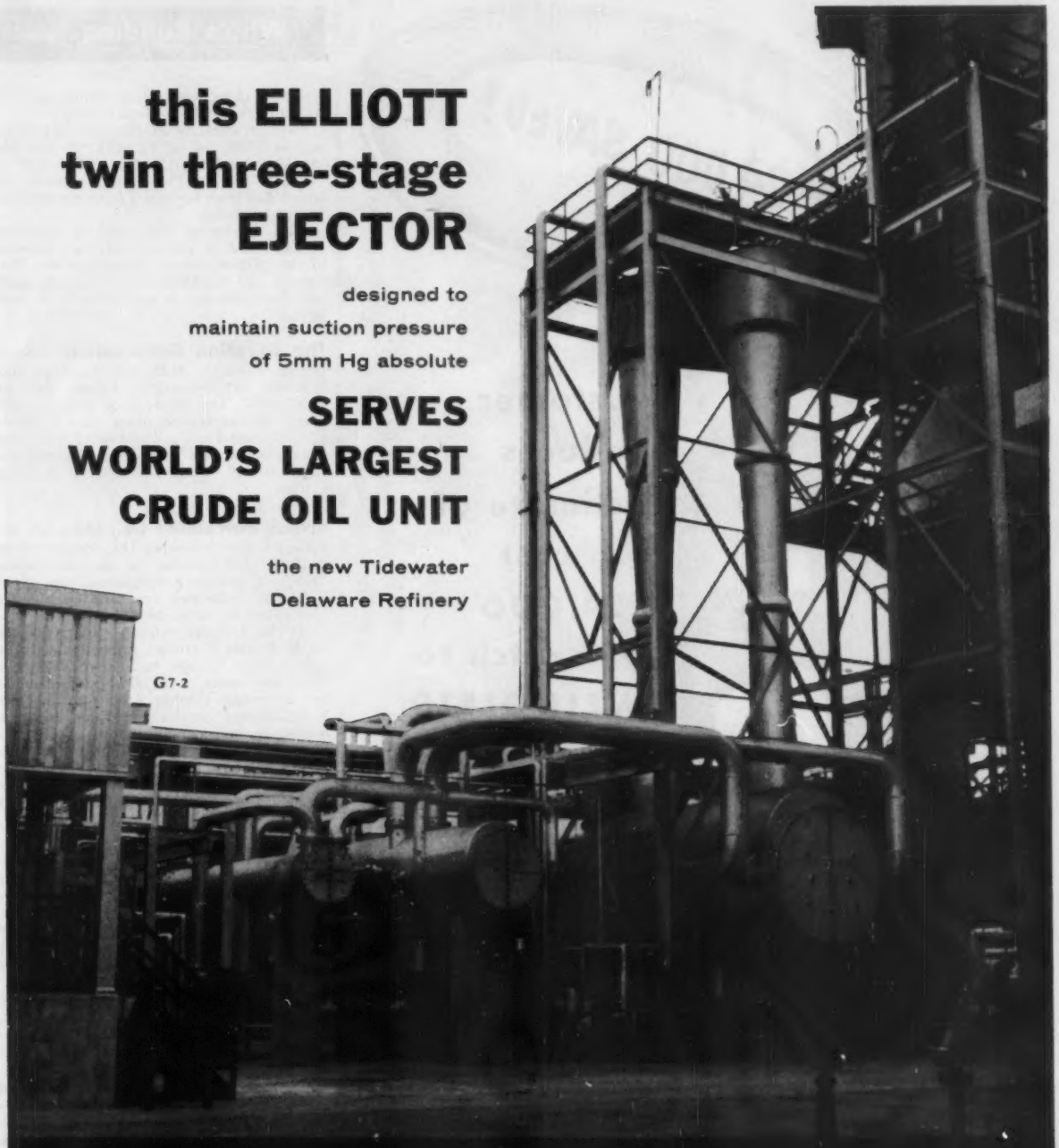
For more data on advertised products, use Readers' Service Cards, last page.

this ELLIOTT twin three-stage EJECTOR

designed to
maintain suction pressure
of 5mm Hg absolute

SERVES WORLD'S LARGEST CRUDE OIL UNIT

the new Tidewater
Delaware Refinery



The giant-sized Elliott twin ejector is the largest vacuum installation ever built. It was designed to maintain a suction pressure of 5mm Hg abs and uses approximately 85,000 lb of steam per hour. The two vertical first-stages have 60-in. diameter inlets and are 40 ft long. They discharge to the 20,000-sq ft intercondenser on the right. Two 20-in. second-stage ejectors discharge to the 6000-sq ft intercondenser in the center. The 3000-sq ft aftercondenser is seen on the left.

Elliott builds steam jet ejectors in a complete size range, single-stage and multistage, to serve all sorts of chemical and industrial processes requiring the use of vacuum.

ELLIOTT
Company
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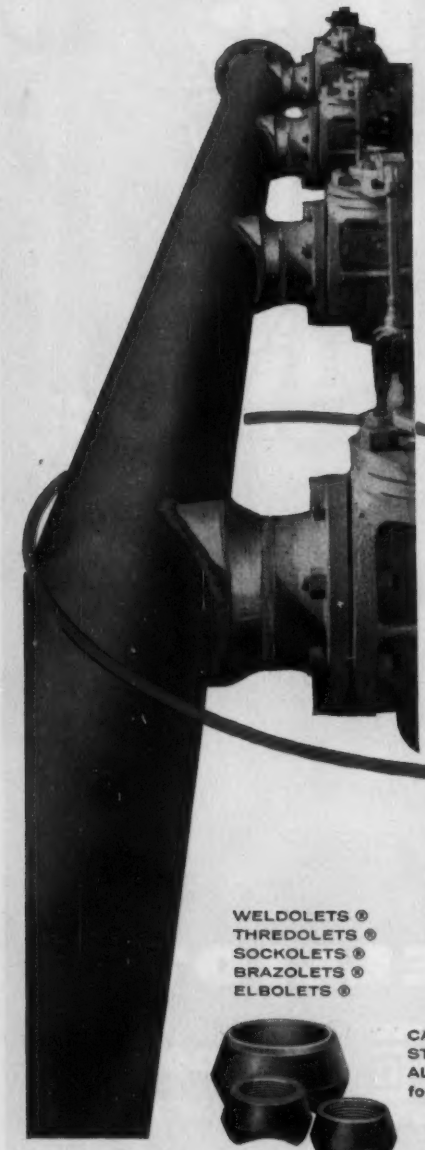
customer reduces estimate of job cost $24,000 by switch to WELDOLETS



An oil piping contract recently was reduced by $24,000 by changing specifications to WELDOLET welding fittings.

Comparable savings are possible on almost every piping contract. It will pay you to examine this positive means of reducing your piping costs. Write us for details.

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Who's Building . . .

trols. All three were designed and licensed by Universal Oil Products Company.

Charge capacity of the new Unifining unit is 5000 bpd of straight run and visbreaker gasoline. Of this 3000 bpd is charged to the Platformer, capacity of which has been increased from the original 2400 bpd design.

The Unifining unit has a stabilizer column and a splitter column. Bottoms of the splitter column are sent to the Platformer and Unifined stabilized light gasoline from the top is sent directly to storage.

The Egyptian Government was reported to have dedicated its new Mex Refinery at Alexandria, Egypt, during June, 1957. The Minister of Industry said upon dedicating the plant that it would be increased from a capacity of 4000 bpd to 15,000 barrels daily, and that the nation's fourth refinery would be built at Cairo.

British Petroleum Co., Ltd., has announced that following the completion of major modifications to the distillation units and ancillary equipment, two of its European refineries are now capable of processing an extra 38,000 bpd.

At the Antwerp refinery, jointly owned by B. P. and Petrofina, capacity has been raised from 65,000 bpd to 90,000 bpd. Two new units, a 10,000-bpd hydrofiner for removing sulphur from gas oil and a 10,000-bpd catalytic reformer for producing a high grade motor spirit component, are to be commissioned next year at this refinery.

B. P.'s Hamburg refinery is now capable of processing 45,000 bpd. Until recently its capacity was 32,000 barrels.

Standard-Vacuum Oil Co. has completed the first catalytic cracking unit to be built in Southeast Asia at the Sungei Gerong refinery near Palembang, Sumatra. The $8 million plant will allow production of 6100 bpd of high-quality anti-knock gasoline components by fluid cat cracking of Sumatra crude.

Included in a general $31 million refinery expansion program are, in addition, a reformer stabilizer, a catalytic polymerization plant, a sulphuric acid manufacturing unit.

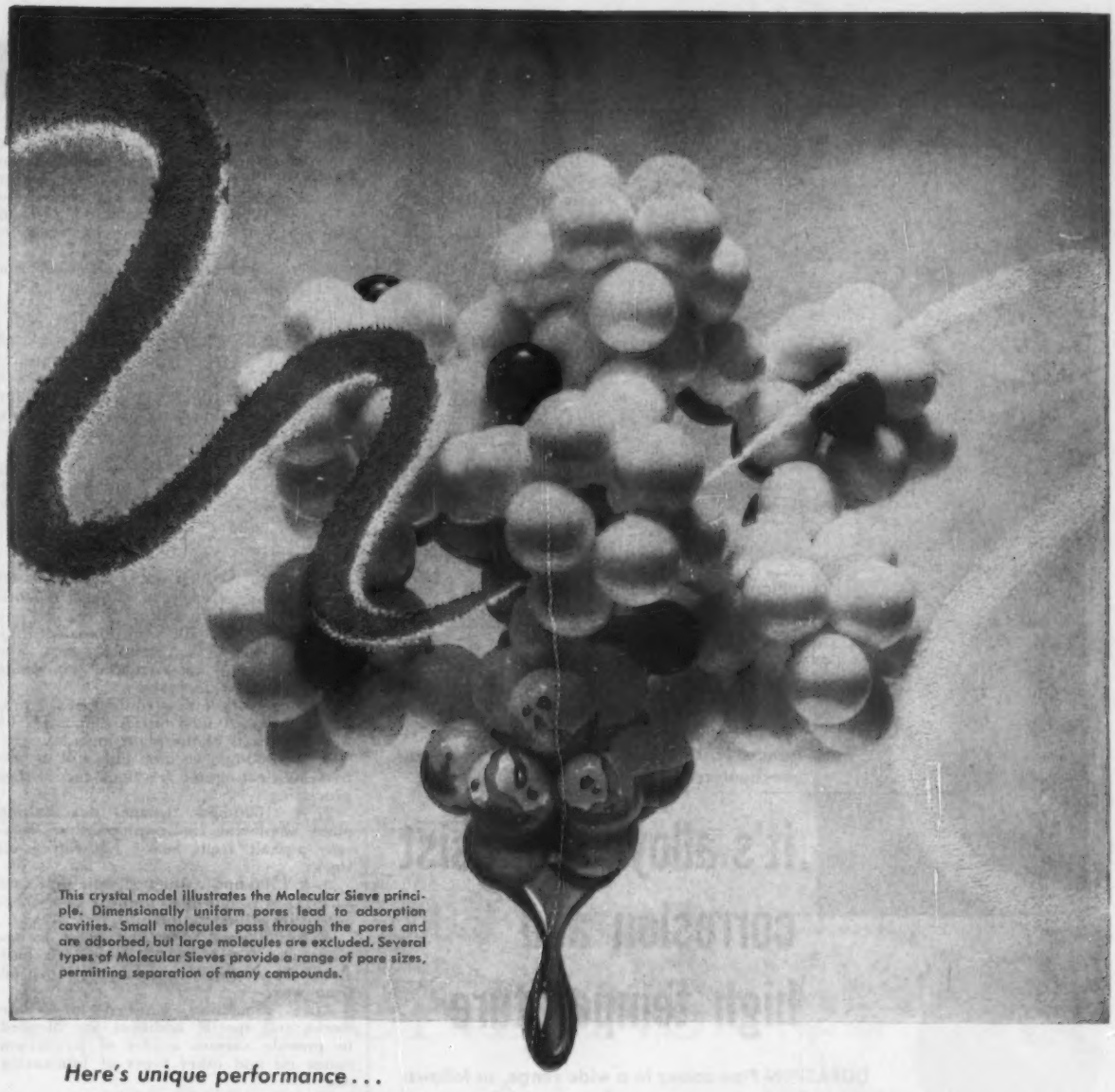
Two 3000-hp gas turbines are installed in the new cat cracker, fueled by refinery gas. Foster Wheeler was the contractor. Raymond Concrete Pile Co. provided foundations for the cat cracker and other Sungei Gerong process units.

Standard Oil Co. (Indiana) announced it will soon begin construction of a new large-volume crude oil distillation unit at its Whiting refinery.

Arthur F. Endres, refinery manager, said the new unit is designed to process 140,000 barrels of crude oil daily, more than twice the capacity of a similar new pipe still put into operation at Whiting early last year.

"The new crude oil distillation unit will substantially increase the efficiency of refinery operations at Whiting," Endres said. "It will permit us to discontinue operation of many small and obsolete units in use for many years."

Scheduled for completion in 1959, the



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

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Molecular Sieves for Purification and Recovery!

. . . selective removal of contaminants, at temperatures up to 300°F!

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Molecular Sieves, a new class of adsorbents developed by Linde Company, offer selective separation of gas or liquid mixtures in three ways . . . difference in molecule size . . . or polarity . . . or carbon bond saturation. And, co-adsorption can be utilized to remove several impurities simultaneously.

Typical uses? Removal of catalyst poisons from olefins . . . or extraction of olefins from refinery streams and top gases . . . or simultaneous dehydration and sweetening of natural gas . . . and many, many others.

LINDE Molecular Sieves offer new performance advantages . . . for many production uses. You may be able to lower costs, simplify processes, improve a product with this unique adsorbent. Find out more by writing for data describing Molecular Sieve properties and performance characteristics, Dept. PR-12, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

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Centrifugally Cast

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You will find SAFETY in DURASPUN Centrifugally Cast Pipe. It's very strong, with strength approaching that of forged steel. It can be alloyed to give you maximum resistance to the heat and corrosion to be encountered.

.it's alloyed to resist corrosion and high temperature

DURASPUN Pipe comes in a wide range, as follows:

Outside Diameter	Minimum Wall	Length
2½" to 3"	1/4"	88" maximum
3" to 6" Inclusive	5/16"	110" maximum
Over 6" to 12" Inclusive	3/8"	168" maximum, 24" minimum
Over 12" to 14" Inclusive	7/16"	168" maximum, 24" minimum
Over 14" to 20" Inclusive	1/2"	180" maximum, 48" minimum
Over 20" to 24" Inclusive	1/2"	88" maximum
Over 24" to 32" Inclusive	5/8"	80" maximum

This is standard piping. Special cylindrical shapes in comparable high alloy steel can be cast centrifugally . . . retorts, furnaces, fractionaters and other such equipment come in this class.

Write us about your requirements. Our metallurgists backed by thirty-five years of experience will be glad to help select the best combination of alloying elements to take care of your operating conditions.

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Who's Building . . .

new unit is planned as part of an extended Whiting refinery modernization program. It will be one of the largest crude oil distillation units built anywhere.

Arthur G. McKee Company, Cleveland, has been selected as prime contractor for construction of the new facility.

Cost of the new crude oil distillation facility was not disclosed.

Premier Oil Refining Co. has placed on stream a 1500-bpd UOP Platforming unit at it's Longview refinery. The unit will operate in combination with a Unifining unit, of the same design capacity, which will pretreat feed stock derived from East Texas crude.

This is the second Platformer operating at a Premier refinery. The first one, located at the Fort Worth refinery, has been operating since July, 1951.

Standard Oil Co. (Indiana) has placed in operation a new, modern lubricating oil plant at Casper, Wyo.

It is the only lube oil manufacturing facility in the Rocky Mountain area. The four-acre plant has replaced processing units in use for 38 years.

Capacity of the new equipment for producing finished lube oils is 800-bpd. The four new units of the plant include:

1. A 4800-bpd vacuum pipe still to prepare lubricating oil fractions for further processing.
2. A 1000-bpd 2-stage deasphalting plant employing liquid propane to separate asphalt from heavy lubricating oil stocks.
3. A 1500-bpd extraction unit that uses furfural as a solvent to improve flow characteristics of lubricating oil.
4. A 2000-bpd dewaxing plant to remove wax from refined motor oil base stocks. It may also be used to remove oil from wax.

After processing, finished lube base stocks and special additives are blended to provide various grades of premium motor oil and other types of lubricating oils.

The Casper refinery's lubricating oil plant is one of several new refinery processing plants Standard Oil has completed and put into operation this year at six refineries in midwestern states.

Shell Chemical Corp. recently completed the first major expansion of office, laboratory and storage facilities at its Norco, La., chemical plant at a cost of more than $500,000.

The largest portion of the project was the construction of a two-story, air-conditioned laboratory and three small buildings including a process development laboratory. The remaining work consisted of extensions to the administration building and change house, additions to the warehouse and warehouse office and new outside storage slabs.

Pontiac Refining Corp. has awarded The Fluor Corp., Ltd., three contracts, totalling approximately $1.5 million.

The first calls for the engineering-construction firm to redesign and modify the No. 2 crude unit at Pontiac's Corpus Christi refinery. When construction is

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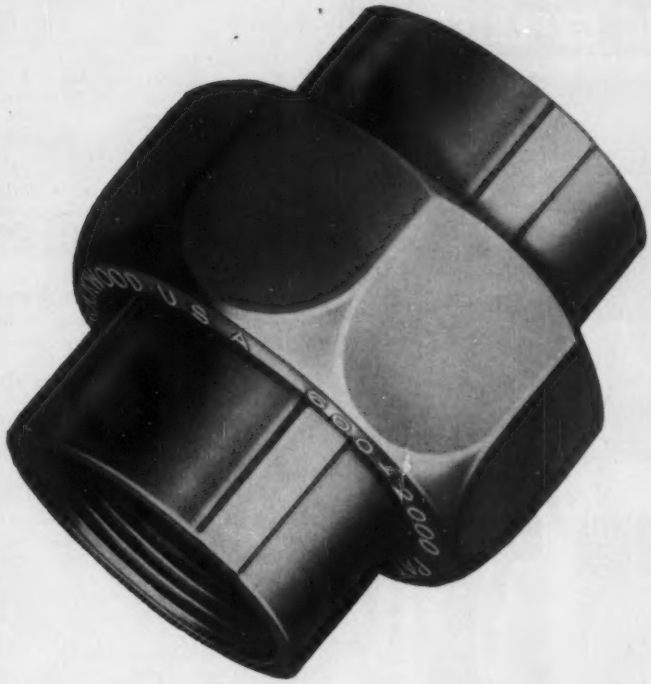

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NOW... Color-Coded for Easy Inspection!

Each Rockwood Union is color-coded to permit quick easy inspection by pipe fitters and warehouse personnel. Parts are completely interchangeable.

Only Rockwood offers you four different seats — for all general piping requirements — approved by Underwriters' Laboratories, Inc., for use in handling flammable liquids. Only Rockwood Unions are "Rockwoodized" for complete protection against corrosion of seat and threads — and are sold off the standard Black Steel price list. Send for full information and take your choice. The coupon's handy — and these unions are handier.

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Distributors in all principal industrial areas

Type 601 Gray... ***Silicon Bronze Seats...***

Eliminates corrosion, electrolytic action and dezincification of seat joint. Withstands higher temperatures than ordinary bronze or brass. Perfect for chemical, steel, rubber, paper and textile industries!

Type 602 Black... ***2 Stainless Steel Seats...***

For use where severe temperature or acid conditions are prevalent, eliminates necessity of an all stainless steel union.

Type 603 Olive Drab ***...Moly Steel Seats...***

Offers extra strength, toughness and resistance against corrosion and provides Hardness Differential. The male seat is specially heat treated to give it a greater hardness than the female seat.

Type 604 Gray... ***Moly to Silicon Bronze Seats...***

Here's a combination union with steel to bronze seats, that combines the advantages of types 601 and 603.

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Name.....

Title.....

Company.....

City.....*Zone*....*State*.....

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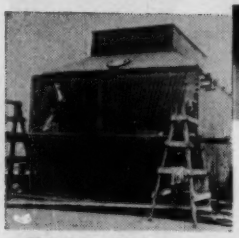
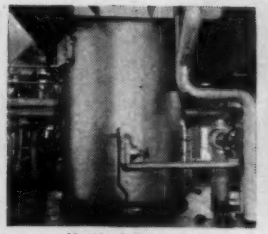
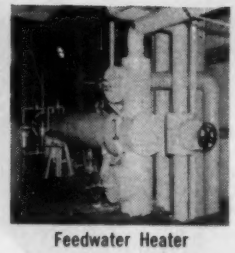
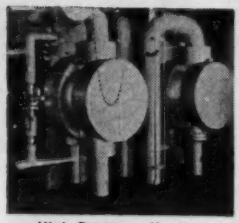
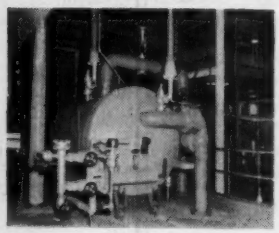

45,000 Sq. Ft. Condenser

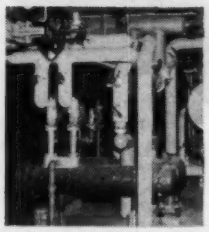
Condensate Cooler

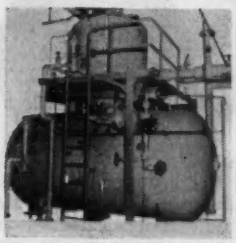

Vertical Deaerator

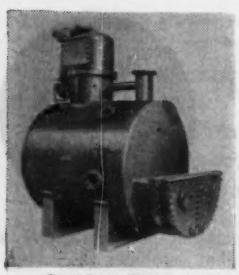

Feedwater Heater


High Pressure Heaters


Evaporator


Steam Jet Air Ejector


Horizontal Deaerator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COMPLETE BULLETINS SENT ON REQUEST

Who's Building...

completed in the summer of 1958, this unit will be capable of super-fractionating 10,000 bpd of sour crude.

Fluor will also engineer and construct a 5000-bpd Naphtha Unifiner at the Corpus Christi refinery. This unit will desulfurize naphtha fractions produced in the expanded sour crude unit.

The third contract calls for a study of the firm's gas recovery plant to determine the most economical method of modifying it to handle miscellaneous refinery gas streams which are now going to fuel gas.

Edwy Rolfe Brown Petroleum Building, Marietta College, in Marietta, Ohio, is now in use, having been used by students for the first time about midway through the past scholastic year after construction was completed, following laying of the corner stone in 1955. Marietta College is one of the oldest colleges in the U. S. and one of a few in the East Offering a degree in Petroleum.

Elbyn, a Greek corporation, has received a 10-year lease to operate the new Aspropygos refinery, near Pireaus. The plant, which has a capacity of 27,000 barrels daily, was completed early in 1957. Elbyn also operates a 500 bpd lube oil refinery at Athens. Esso Export Corp., Jersey Standard affiliate, will supply the Aspropygos refinery with crude oil, and will furnish technical help to assist in operation of the refinery.

Foster Wheeler Corp. will supply process design, mechanical design and engineering for a 150 metric ton per day ammonia synthesis gas generation plant for Sincat, Priolo, Sicily. Sincat is a newly formed petrochemical company wholly owned by the Edison Co., Italy's major public utility.

The Texaco synthesis gas generators are designed to burn either gaseous or liquid hydrocarbons.

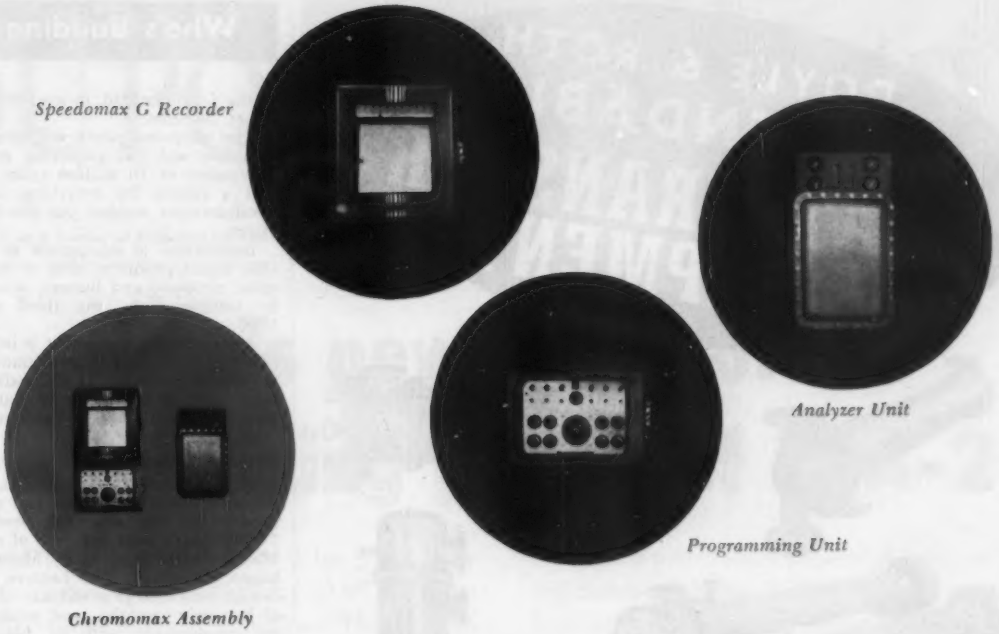
Refineria de Petroleos de Escombreras, S. A. (REPESA) has announced that the first UOP Platforming unit built in Spain and one of the largest constructed on the European continent has gone on stream recently at its Cartagena, Spain refinery.

The 11,000 bpd unit is designed to produce a 90 clear octane blending component by processing straight run naphtha derived from Middle East crudes which are basically Saudi Arabian in origin. The naphtha boils in the rage of 190° to 350°F.

Universal Oil Products Co., Des Plaines, Ill., provided process designs and licensed the unit. REPESA is owned by the National Institute of Industry (INI), Caltex Oil Products Co., and Compania Espanola de Petroleos, S.A. (CEPSA).

Sinclair Oil & Gas Co. has authorized the construction of Gas Products Plant No. 29 in Lea county, N. M., to conserve and process oil-well gas from three pools in the West Texas-New Mexico area.

The plant will process gas produced in the Gladiola and North Gladiola pools of Lea county, N. M., and the Bronco pool of Lea county, N. M., and Yoakum county, Texas. The plant will be located



Speedomax G Recorder

Analyzer Unit

Programming Unit

Chromomax Assembly

inside story of CHROMOMAX*

. . . your key to process stream analysis

With the new L&N Chromomax Gas Chromatography Analyzer, you get a realistic picture of your process streams containing natural gases, vapors, low boiling point liquids or hydro-carbons up to C_8. A single Chromomax analyzes up to four streams . . . up to eight components per stream.

The complete integrated instrument assembly consists of an explosion-proof analyzer unit, a programming unit and a Speedomax® G Recorder. The analyzer unit provides: (1) temperature control from 50 to 120 C to an accuracy of better than ±0.1 C in the presence of ambient swings as great as 60 F; (2) an air circulation system that does not use blower motors; (3) detectors consisting of special low volume cells with hot wire filaments.

Features of the programming unit include: (1) a panel containing complete controls to perform an analysis; (2) continuous peak attenuation of each component being measured; (3) a recorder chart advance which is activated from this unit.

The Speedomax G Recorder draws either a bar record or a spectrum of an analysis; it automatically zeros the bridge circuit after each analysis cycle.

Additional design features, such as plug-in components, give you an instrument with minimum downtime and low maintenance. If you have a problem that gas chromatography can solve, get the inside story on Chromomax. Contact your nearest L&N Sales Office or write to Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa. for Folder ND46-91 (7).

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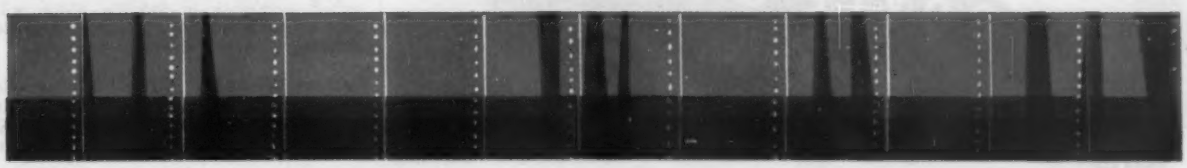

For more data on advertised products, use Readers' Service Cards, last page.

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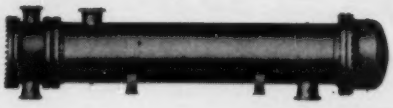

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Who's Building...

in the Gladiola field, in township 12 south, range 38 east.

The proposed plant will provide for a complete wet gas gathering system with a capacity of 10 million cubic feet daily, and a system for returning dehydrated, desulphurized residue gas for lease operations.

Installation of equipment to make specific liquid products, such as natural gasoline, propane and butane, is expected to be completed by the third quarter of 1958.

After process equipment is installed, the plant will produce approximately 15,600 gallons of propane, 11,600 gallons of butane, and 8800 gallons of natural gasoline, or a total of 36,000 gallons daily.

Foster Wheeler Corp. will provide process and mechanical design, engineering and construction for two direct-fired heaters for the potential production of 21,000 metric tons per year of ethylene at Maersk refinery of A. P. Moller, Copenhagen, Denmark. The heaters, of special design, will charge a mixture of 3500 bpd of lt. virgin naphtha, and steam; the outlet temperature will be approximately 1400 F.

Foster Wheeler will also revamp the existing vapor recovery section of this plant.

Standard Oil Co. (New Jersey) has formed a new affiliated company which will build a $30 million petroleum refinery in Norway. The Norwegian company, fully owned by Jersey Standard, will be known as A/S Esso-Raffineriet, Norge.

In announcing the formation of the new Norwegian company, Jersey Standard said that construction of the installation, the first major refinery in Norway, will begin in 1958.

The location of the new refinery has not yet been determined. Construction problems occasioned by special soil conditions in Norway have necessitated extensive studies of many possible sites. Several locations on the Oslo Fjord are being evaluated by Jersey experts.

The projected refinery has been designed to process approximately 40,000 barrels of crude a day from Middle East sources. Principal products will include gasoline, jet fuel, heating oil, diesel oil, heavy fuel oil and marine bunker fuel. If the site location permits, a terminal will be designed so that with later expansion it will be able to accommodate the largest tankers presently planned.

At present the only other refinery in Norway is a small plant for the manufacture of lubricating oils and asphalt which A/S Esso Norske, another Jersey affiliate, has operated at Vallo since 1899.

It is estimated that operation of the new refinery would save Norway an appreciable amount of dollars in foreign exchange. Initially, about half of the refinery's products will be needed for sale in Norway by A/S Esso Norske. The balance of the refinery's output will be exported, primarily to Sweden which will help improve Norway's balance of trade with that country it was pointed out.

Foster Wheeler Corp. will provide process design for a synthesis gas plant at Kowasaki, Japan for Showa Denko K K, Tokyo, Japan. The capacity of the

DU PONT *Petroleum Chemicals* NEWS

Number 82 in a Series of Bulletins for the Petroleum Industry

DECEMBER 1957

Here's new proof of the solubilizing power of FOA-2

DuPont Fuel Oil Additive No. 2 has long been known as an exceedingly effective fuel oil-stabilizer and sludge-dispersant and solubilizer. The first two qualities have been repeatedly demonstrated in field performance, and now the solubilizing power of the additive can be demonstrated also.

The demonstration is quite simple and can be made with no more equipment than a heat source (steam bath) and two small vials of fuel. The fuel is kerosine with a small amount of benzene containing dissolved sludge. FOA-2 is added to one of the fuel samples; then the benzene is boiled off of both samples. The time-lapse picture story (below) tells the story.

How FOA-2 solubilizes

The photos show that at the beginning sludge is soluble in the fuel, becoming insoluble

OVER

1 10:30 A.M., SEPTEMBER 23, 1957

2 10:42 A.M., SAME DAY

3 11:42 A.M., SAME DAY

4 1 P.M., SAME DAY

5 10:30 A.M., NEXT DAY

1. These bottles both contain 99% kerosine, 1% benzene and a small amount of sludge (15 mg/100ml) which is soluble in the fuel blend. To the bottle at right .01% of DuPont FOA-2 has been added. This is the proportion recommended for protecting fuel oils (30 lb./1,000 bbl.).

2. The samples have been heated for 10 minutes in boiling water to evaporate the benzene. Sludge is already starting to appear in the bottle at left, not in bottle at right.

3. Note in cut 3 agglomeration of insoluble sludge particles at left, and clarity of FOA-2 protected oil at right.

4. Sludge formation has settled to bottom. Solution at right remains clear.

5. Most of the small sludge particles in left-hand bottle have now settled. After 24 hours, FOA-2 protected oil still shows no sign of sludge precipitation, and will continue clear almost indefinitely.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

CONTINUED *Solubilizing Action*

only when the aromatic solvent portion (benzene) is removed. The right-hand bottle shows that FOA-2 keeps the sludge soluble, whereas it gradually precipitates in the bottle at left.

FOA-2 is a long-chain polymer with a critical balance between polar and oil-soluble groups. The polar groups are attracted to non-hydrocarbon constituents or residue particles, and the soluble groups maintain good oil-solubility of the combination.

FOA-2 *stabilizes* fuel by preventing interaction of non-hydrocarbon constituents or residue-formers in the fuel. It *solubilizes* some residues which are just slightly insoluble, and *disperses* other residue particles which are quite oil-insoluble.

Benefits of the additive

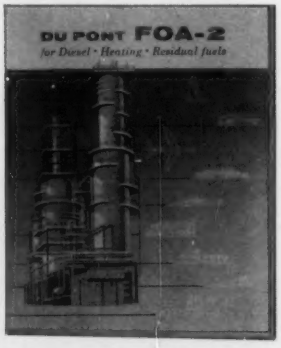
These three properties of Du Pont Fuel Oil Additive No. 2 keep oils free flowing . . . devoid of sludge which could cause clogging of heating systems.

They are responsible also for FOA-2's solution of the incompatibility problem. The sludge likely to precipitate when oils are mixed does not form if sufficient FOA-2 is present; 30 lb./1,000 bbl. is usually enough to solve incompatibility.

The third important function of the additive is its cleansing of systems already fouled with sludge. This saves the costs of downtime and of having systems cleaned manually.

New book about FOA-2

We recently published a comprehensive 28-page book about FOA-2. All



the basic information you will need is included—properties, composition, use concentrations, handling and addition methods, and performance testing data. Ask any of our representatives for a copy, or drop us a line.

You ought to know . . .

CARL W. FERRIS is manager of the Du Pont Petroleum Chemicals Division's Chicago district. This district serves the tetraethyl lead and other additives needs of refineries in Illinois, Indiana, Missouri, and parts of Michigan, Iowa, Kentucky, Tennessee and Wisconsin.

Mr. Ferris was previously an account manager in the Division's central region office which is headquartered also in Chicago. He joined the Du Pont Company in 1947 and his first assignment was at the Du Pont Petroleum Laboratory where he worked on fuel blending studies in the single cylinder engine laboratory. He then did road test work with the Du Pont fleet of fuel test cars. He was transferred to the Division's central region in 1951, where, before becoming an account manager, he was the regional automotive service representative and then sales promotion coordinator.

A graduate of Cornell University, Mr. Ferris has a B.S. degree in mechanical engineering. During World War II, he served for nearly 3 years in the U. S. Navy and held a Lieutenant, jg. commission. He is a member of the Society of Automotive Engineers.

How educators get practical industry experience at Du Pont

When a college professor tells a class of future chemists "how we used to do it at the plant," there's a good chance he's talking about the sound practical experience he picked up in industry.

The growing number of educators participating in Du Pont's summer employment program enjoy the opportunity of gaining experience and knowledge of industry which help them in their academic careers. They also supplement their incomes by summer work.

In helping educators in this direct way, Du Pont and many other industrial companies are contributing to a movement directed to the promotion of better industry-education understanding.

Du Pont broadened its summer program this year to include nearly 60 high school teachers and college professors. These men and women can draw on the experience they acquired at Du Pont plants or laboratories in 13 different states to help out with the vital job of training today's youngsters for tomorrow's jobs in industry and education.

The summer employment of college professors began just after World War II. Recently Du Pont employed high school teachers as well.

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

A-5709

Printed in U. S. A.

Who's Building...

plant will be 121 short tons per day of hydrogen-nitrogen syn gas for ammonia synthesis. The plant will comprise an oxygen compression section, 2 Texaco generators, shift conversion, and CO_2 removal.

Shell Chemical Corp.'s Norco, La., plant has begun initial testing and preliminary operations at its new hydrogen peroxide and secondary butyl alcohol units.

Construction of facilities for the manufacture of hydrogen peroxide was started in mid-1956 after pilot plant operations had proved the process successful.

In January 1957, construction of the secondary butyl alcohol unit was started. Known as the S unit, it is designed to produce 40 million pounds of SBA per year. SBA is used at the Shell Chemical Houston plant primarily as an intermediate in the production of methyl ethyl ketone for the paint and lacquer industries.

Both new units were put on stream during the last month and complete the current major expansion planned at Norco.

Development and Resources Corp. plans to carry out construction of the following projects in Iran:

1. A natural gas pipe line from Agha Jari oil field 70 miles to Ahwaz to provide the raw material for future petrochemical plants there, including:

2. A polyvinyl chloride plastics plant at Ahwaz, which will utilize casinghead gas now being flared in the South Iran fields located north and northeast of Abadan.

David E. Lilienthal is chairman of the board of Development and Resources Corporation, and Gordon R. Clapp is president.

Austrian Mineral Oil Administration (AMOA) plans to build a new 47,000 barrels per day refinery at Schwechat, near Vienna. Completion is planned for 1961. A West German engineering firm was being retained to draw up formal plans.

Erdoelwerke Frisia, A. G., a newly organized German company, has awarded a contract to Ralph M. Parsons Co., Los Angeles, for the construction of a 30,000 bpd refinery at Emden.

Frisia is an independent company which will be promoted by Guttlieb Duttweiler, Swiss financier who heads the Migros Cooperative, a large grocery merchandising concern. The co-op organized a gasoline marketing subsidiary, Migrol, several years ago and started gasoline price wars with the major Swiss marketers.

Duttweiler will have only a small financial interest in Frisia, but his firm will take at least 1500 bpd of the refinery's expected 5000 pbd production of gasoline.

Migrol's initial holding in Frisia amounts to only $716,000. An American independent, which will supply Wagra crude from the Neutral Zone under a 15-year contract, will have around a $953,000 interest.

The rest of the capital needed to finance the project will come from Emden shipbuilding firms, German industrial investors, and private German investors.

The refinery is expected to be on stream sometime in 1959.

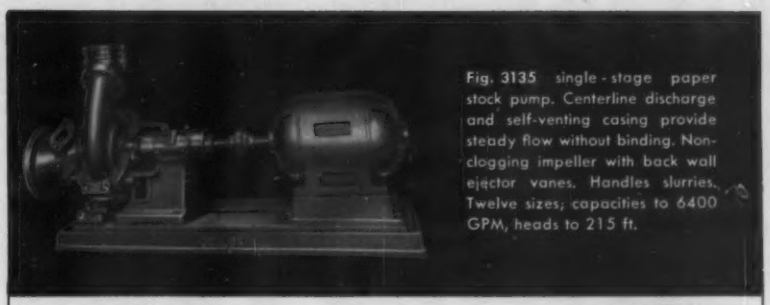
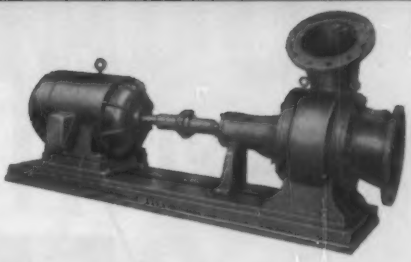


Fig. 3135 single-stage paper stock pump. Centerline discharge and self-venting casing provide steady flow without binding. Non-clogging impeller with back wall ejector vanes. Handles slurries. Twelve sizes; capacities to 6400 GPM, heads to 215 ft.

Fig. 3138-39. Specially designed for heavy duty service, pumping corrosive or noncorrosive liquids, with or without solids in suspension. Vertically split casing, "back pull-out" design. Four sizes; capacities to 9000 GPM, heads to 160 ft.



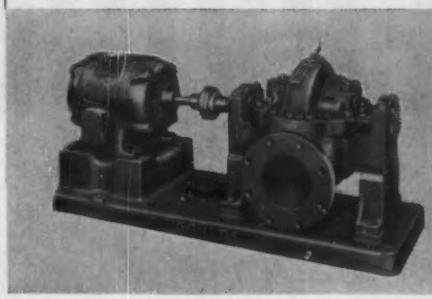


Fig. 3405 single-stage, double-suction pump. All sizes and pump combinations based on only 3 shaft and bearing assemblies. Mechanical seals or stuffing boxes. Rotation can be changed in field. Thirty-three sizes; capacities to 6400 GPM, heads to 425 ft.

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You can solve corrosive pumping problems quickly because a number of Goulds centrifugal pumps now come in a wide range of special metals.

You can get them with fluid ends in your choice of the special metals listed below. Just match the special metal to your pumping problem.

All Bronze
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All Iron
Bronze Fitted
Nickel Aluminum Bronze
Steel and Steel Alloys

What's more, you'll get prompt delivery on these pumps (or any of four other types) in corrosion-resistant constructions from Goulds foundries.

You can keep spare parts inventory low, and meet quick changes in process requirements because Goulds pumps are designed with standardized parts for easy interchange between sizes.

Bulletin 5252-J has brief descriptions of these pumps (and the Goulds-Pfaudler *glassed* pump). Write for a copy.

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As Management Sees It

Yardstick for Decision Makers

THE PRINCIPAL VALUE of "Operations Research" and the other management sciences lies in making available to management better measurement of the variables under management's control. The management sciences provide useful *yardsticks for management* where hunch, intuition, trial and error, and other expedients have been used in the past.

This is not to suggest that management has had no yardsticks. If anything there have been too many, usually with dollar marks instead of inches, but usually with different dollars as the basis for the marks on the various yardsticks.

An example may clarify the point: A major producing company expressed grave concern about the "high" cost of maintaining its production; it was using a dollar yardstick on which the intervals were out-of-pocket dollars (the kind that always hurt most). If this were a "closed" problem and the out-of-pocket dollar measure were valid, the obvious solution to the problem would be to stop maintaining the fields! Obviously, this is no solution.

But a solution begins to emerge when maintenance dollars are looked at as investment dollars from which a maximum return is expected. Before the maximum return can be computed, the critical variables in the system must also be measured: What is the best rate of field development in terms of the associated maintenance problem? What is the effect of the increasing age of the producing wells on maintenance requirements? What is the effect of developing more and more remote areas as the readily accessible areas are worked out and abandoned? If an increase or decrease in maintenance equipment is indicated by the analysis, what units should be acquired or retired? Are technical personnel available for expansion of the maintenance effort, if this is indicated? These are just a few of the questions that must be answered before management has at hand a yardstick that states accurately whether or not the maximum return is being realized on currently allocated maintenance dollars—or whether the current allocation should be increased or decreased *and by how much.*

It is interesting to note, parenthetically, that many analyses which started because of someone's interest in "cost reduction" (usually in the maintenance and inventory areas) end up in recommendations to increase the investment in maintenance or inventory, as the case may be. For just as the wrong yardstick (out-of-pocket dollars) is usually used where maintenance is concerned, other wrong yardsticks are used for inventory. Thus, carrying costs or obsolescense costs usually loom large in a manager's eyes, frequently to the exclusion of the high costs of the increasingly frequent setups that become necessary as inventory is reduced.

Operations Research can be a valuable tool for refinery management . . . if it is understood and applied correctly

Operations Research Method. How do the management sciences go about providing better answers more quickly?

Perhaps the following description of the systematic approach used in an Operations Research study will help answer this question.

Preliminary Look. The usual first step in conducting an Operations Research study is to observe the system or operation as it is operating. For a new group or team this is, of course, essential, but even a group or team that has been working in an organization for some time must "review" occasionally, especially before starting on a new kind of problem.

Observation of the physical operations is *necessary* to a preliminary understanding, but a very careful look at the flow of information is essential

—for decisions are based on information and are themselves an input to the information system. Hence, information flow is all important.

A very effective device is to lay out the information flow and materials flow on an actual plan of the facility in which the operation is being conducted. Such a layout frequently reveals anomalies that have "just growed" and can be corrected quite easily to the benefit of the whole organization. For example, two offices which exchange considerable amounts of information may have become separated because of space requirements—without considering the delays resulting from such separation.

Once the flow of information, and its relationship to the physical operation, is understood, specific problems of information flow, process control, inventory control, and the like begin to appear. This provides a rational basis for a meeting with management in order to select the problem area that will get first priority.

Formulating the Problem. By the time of the management meeting, the research team will have a good idea of the probable payoff to be obtained from the solution of the several problems. It will also have a good idea of the time and effort that will be required for a solution. More important, it will have had a chance to discuss objectives with management so that a suitable *measure of effectiveness* can have been developed. This will usually be a least cost or maximum profitability measure, but it will be subject to restrictions like stable employment or relations with labor or the community.

In the meeting with management, various assumptions may be agreed upon. These are necessary as a means of reducing the problem to manageable proportions, but they are also necessary to agreement on objectives. The need for additional, more detailed assumptions will arise as the research proceeds—and even the initial assumptions may have to be changed.

The most important element in formulating the problem is the determination of genuine cause-effect relationships. A company may be convinced that its market is changing, and may demand a marketing study, when its real problem is that its own technology has failed to keep pace. Or it may have the very latest equipment, but may be using it exactly as it used its older equipment, wondering the while why costs are going up so rapidly. The basic objective of the Operations Researcher is essentially the same as that of the medical practitioner: He wants to get at causes; he does not want to treat symptoms.

Developing the Model. The next step is to develop a model of the system under study. This may be verbal, at first, or it may be graphic or even mechanical, but it soon becomes a mathematical model because of the greater ease with which a mathematical model may be manipulated. In all cases, it will seek out the variables under the control of the client, the variables that he does not control, and the constants (actual or by assumption) in the system. And these are all related to the measure of effectiveness. Most models start out quite complex, but most of the complexity is eliminated by making reasonable assumptions about the non-controllable variables, thus reducing the required manipulation to that concerned with the controllable variables.

In some cases, the model will yield to direct analytic solution. Often only numerical solution or iterative processes can be used because of the complexities involved (or because of the inadequacy of existing analytical techniques).

Techniques. It is in connection with model construction and solution that the greatest misunderstanding about Operations Research has developed. Most of the articles that have appeared on Operations Research are general in nature or they deal with *techniques* of solution of various models. The result is that most people get the idea that Operations Research is some unexplainable brand of hocuspocus because the general articles usually say too little about too much; or they get the idea that Operations Research is a branch of mathematics, if only because the articles on technique can become mighty technical.

Actually, the mathematics used in Operations Research seldom gets beyond basic calculus, fairly elementary statistics, probability theory, and some matrix algebra. Of these, the probability and statistics are probably most important in terms of frequency of use, although matrix algebra receives quite a play because of linear programming.

The basic models are relatively few, but the variations (to adapt the models to particular problems) are practically unlimited in number. The greatest development has come in connection with waiting lines (queues) such as develop when "customers" (parts to be processed, aircraft to be landed, diners to be served, etc.) require service at some facility. Next in state of development is the work on production and inventory control. Problems of maintenance and replacement, sequencing of operations, and allocation of resources to various activities have also had considerable attention and appropriate models have been developed.

Much work is currently going forward on integrated information-handling systems, on programming of research and development, and analysis of competitive systems, to name a few areas, but little of this work has reached the "guaranteed payoff" stage. Some attempts have been made at over-all synthesis of the operations of an entire company, but few of these attempts have as yet been successful, primarily because so few Operations Research groups now working in industry have been in business long enough to have done the necessary background work to make such synthesis possible.

Testing the Model. Once the model has been developed and solved, it must be tested, and data-gathering begins. Up to this point there has been, of course, some data-gathering, but it has been incidental, or should have been. For the model also provides a clear specification of the data required for the solution of the problem.

Once the data have been gathered and reduced, the model is "worked," using the live data from the system under study. If this manipulation produces results that differ from those actually obtained, the model is inadequate or defective and the research must be recycled through model development. Only when the model reflects the existing operation can it be considered adequate.

Then the controllable variables may be altered in order to determine the effects of change in these variables in terms of the measure of effectiveness. In this way a solution is reached.

Testing and Controlling the Solution. But the solution thus reached is a solution only if the assumptions that have been made are valid. Thus it becomes necessary to consider alternate

assumptions (at least those to which the solution is sensitive). The solution may prove valid over a wide range of assumptions or it may prove so sensitive to one or more assumptions that the researcher comes up with alternatives among which management may choose.

Even then, the task is not complete. Suppose that management chooses a course of action based on one assumption or set of assumptions. Then the researcher must also provide management with control limits within which the solution remains valid. If demand, or labor costs, or any other element about which assumptions have been made changes outside these control limits, management will require a new solution—or may even have a whole new problem.

Implementation. Throughout the process just described, the results are being implemented, in the sense that both management and the operating people involved are kept informed (whether formally or informally) as the study progresses.

Management must provide guidance and access to information. Operators must understand what is going on and changes that are to be made, must be within their capability to handle. Frequently, minor procedural changes can or must be made as the study progresses, either to remove obvious anomalies or to obtain needed data. In this way, the entire study is conducted in an atmosphere most likely to ready acceptance of the required changes when they are effected.

It should be pointed out in this connection that change *is* involved. And change frequently engenders resistance at one or more points up and down the line.

Because the Operations Researcher has a constant concern with the problem of implementation (in other words, he is concerned with affecting the real world and is not interested in the mere accumulation of knowledge about the real world), he can usually reduce resistance to change as he goes along. This can—and perhaps should—extend to personnel changes in terms of including such organizational changes as will absorb "displaced" personnel.

For this reason, gradual implementation is frequently a recommendation so that the organizational impact is distributed over time.

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

Is It Easy to Find Oil?

New oil fields are getting harder to find every year. And the cost to develop new reserves is increasing rapidly. In fact, one famous geologist said: "Today, the best place to find oil is in your head," and there's at least 100 billion barrels of bonus oil in the U. S. to prove it. Using all the most modern research techniques and equipment available, oil men "found" this oil by thinking out more efficient means of water-chasing reluctant oil out of old or sluggish fields. Generally, it takes from 10 to 15 barrels of water to flush out one barrel of oil. Finding new methods for recovering additional oil from underground costs the industry millions of dollars every year—but it is one way in which the nation's needs can be met.

Is It Expensive to Drill for Oil?

To give an example, the following product accounts for a small fraction of the total drilling costs. It's name is mud. But far from being common dirt, this fluid so vital for oil well drilling is a scientific blend of special materials which can cost as much as a dollar a pound. Tailor-made chemicals, caustic soda, corn starch, redwood fiber, shredded cellophane, walnut shells, chicken feathers, and any number of other strange materials are added to "mud" to solve drilling problems, such as caving, or controlling gas pressures. Oil wells consume $100 million worth of mud every year—840 gallons every drilling minute!

How Does the Oil Industry Finance Its Operations?

A growing America needs oil—39 billion barrels of it in a ten year period between 1956 and 1965. This is the equivalent of 80 percent of all the crude oil produced in the 98-year history of the domestic oil industry. Finding the oil and bringing it to market will cost a staggering $73.5 billion. Main problem facing the industry is where to find the money. About $44.5 billion may be available from provisions covering the cost of replacing facilities that are wearing out, such as percentage depletion and charges for depreciation. Another $18.5 billion must come from the earnings of oil companies. The remaining $10.5 billion will have to be borrowed from the savings of small investors all over the country. Far from being "money in the bank," these funds will depend on whether the oil man can make a fair enough profit to provide the incentive for others to invest in his business.

FIGURES 1 and 2—The oil burning in the container at left is kerosine. It has a flashpoint of 126° F., and a temperature of 80°. A very small amount of burning gasoline was poured on the surface to ignite it. When some of the oil at 80° F. is brought from below to replace the heated surface of the burning kerosine, the vapor rate is not sufficient to maintain the bottom flammable limit of 1 percent in the vapor-air mixture and the fire is extinguished.

How to Fight Refinery Fires

When a refinery fire occurs, oil and its products should be divided on the basis of:

1. Vapor-air mixture of the burning product
2. Whether the oil is on the loose, or . . .
3. At rest in a pit, pool, tank or other container

J. L. Risinger
Safety and Fire Consultant
Maplewood, New Jersey

KNOWLEDGE OF the conditions under which petroleum and its products burn is the key to fire control.

Each petroleum fuel is manufactured or selected with characteristics of producing the correct vapor-air mixture to burn most efficiently for its specific use. To extinguish a fire in these products it is only necessary to cause change from the conditions under which each of these products are manufactured or selected to burn.

On the basis that oil can burn only when the flames are fed by vapors from it mingling with oxygen in air in the correct percentage, this correct percentage for each product is known as its *flammable* range. The temperature required to cause a specific product to produce vapors at a rate to produce this vapor-air flammable mixture is generally referred to as the *flashpoint* of oil.

If an oil has to be heated to bring it to the characteristics of producing the vapors, then ordinary cooling methods will bring it back out of the temperature range that produces the vapors, and thus the fire is extinguished. Specific product examples are listed below:

Kerosine. When the surface of kerosine is heated to its flashpoint, it produces vapors within the flammable range. When the vapors are ignited and the colder oil below the surface is stirred to the surface, the vapors cease and the fire goes out. (See Figures 1 and 2.)

Gasoline. Products such as gasoline produce vapors within the flammable range at very low temperatures. Therefore, very abnormal cooling methods have to be used to reduce the vapors enough to extinguish the fire. In the case of gasoline and other such products, the easiest and most practical method of breaking up the flammable vapor-air mixture is to reduce the air content. Thus the flammable vapor-air mixture can be broken up (thrown out of balance) and the fire extinguished by either of two procedures: By reducing the air content in the vapor-air mixture below that required—By reducing the vapor content below that required.

How to Reduce Air Content. As a general rule in the case of petroleum and its products, small fires involving all kinds of oil are more easily and quickly extinguished

News on Ethylene from England

Imperial Chemical Industries Ltd., the largest chemical manufacturing firm in the British Commonwealth, is meeting the increased demands for ethylene-derived products with a third ethylene manufacturing plant in northeast England. As the discoverer and a major producer of polyethylene, I.C.I. consumes large amounts of high purity ethylene.

The M. W. Kellogg organization was privileged to engineer I.C.I.'s first two ethylene plants. Kellogg is completing the engineering of the third plant, and has started construction. All three plants utilize the unique Kellogg steam-cracking process which produces exceptionally high yields of over 99% pure ethylene with a high on-stream efficiency.

The close cooperation and interchange of technology between I.C.I. and Kellogg will assure the success of this new plant as it did for the two now in operation. Kellogg's ability to work closely and harmoniously with chemical companies is largely responsible for the organization's leading international position in petrochemical engineering.

The M. W. Kellogg Company welcomes your petrochemical inquiries.

CHEMICAL PROCESS DIVISION

THE M. W. KELLOGG COMPANY

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FIGURES 3 and 4—Fire foam correctly applied at left, will separate air from the surface of the oil if the vapor pressure is not too high. As shown at right, when the suface of the oil is completely blanketed, the vapor-air flammable mixture ceases to be provided and the fire is out.

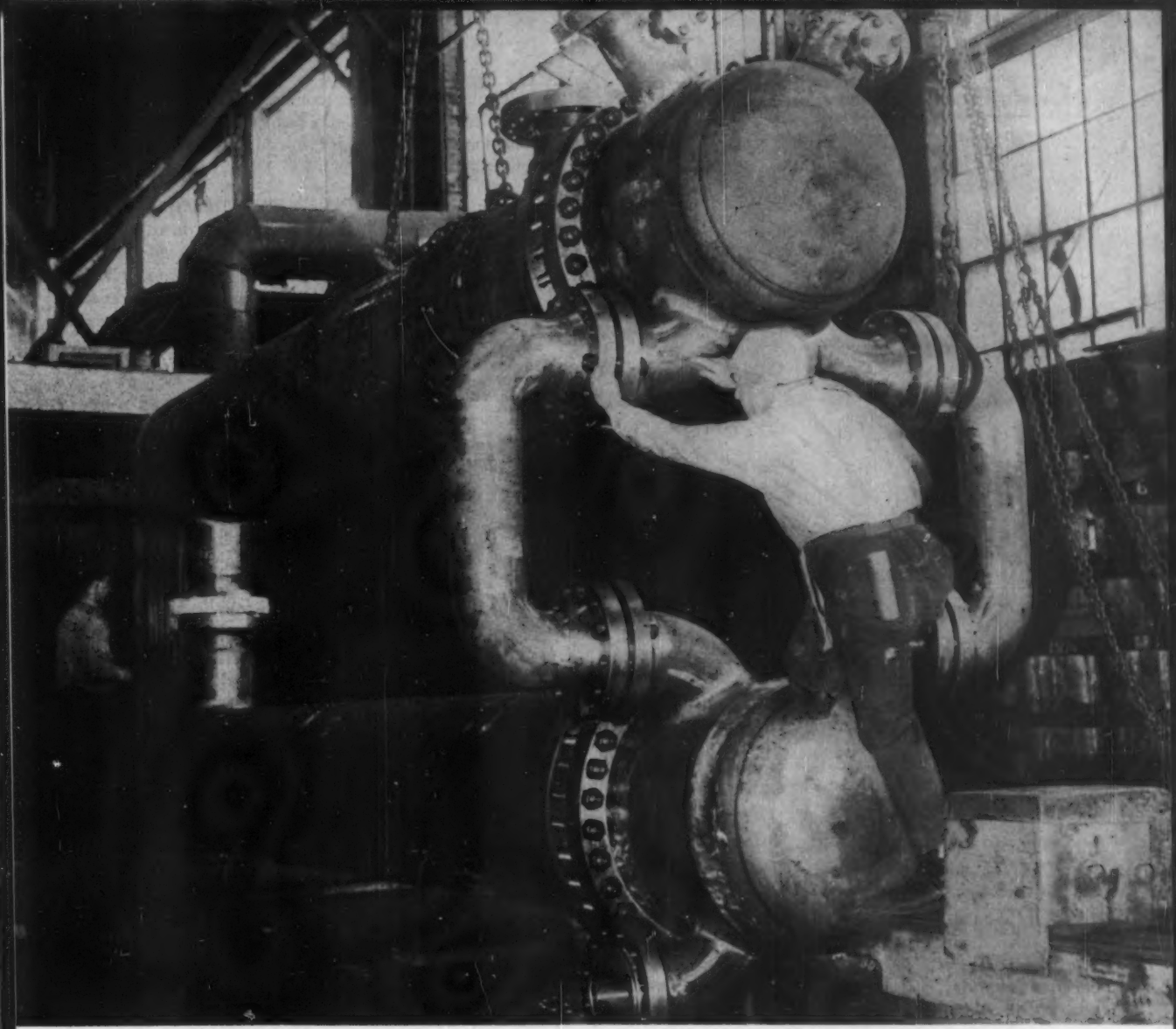
by a reduction of the air content in the vapor-air mixture. All petroleum and petroleum gas fires can be extinguished by this method. Only oils with little or no vapor pressure can be cooled enough to reduce vapors below the approximately 1 percent of vapors (the bottom limit of the flammable range) required to extinguish petroleum fires. The most effective ways to reduce air content are:

1. The use of inert gas or solids to purge the air to below that required which, in the case of petroleum flammable liquids, is approximately 94 percent and in the case of petroleum gases 90.5 percent. Examples of such agencies are carbon dioxide and dry chemical. These appear to be the prevailing small extinguishers, especially in petroleum refineries—CO_2 for enclosures such as laboratories, and electric and dry chemical for all other.

Flammable gases are often used to keep the air content below that required for combustion as an ignition preventative measure. They are not used to reduce the air content after ignition and thus extinguish the fire. Since

FIGURE 5—A pit or a pool of high flashpoint oil can be extinguished by digging a stream of water into it in a manner to stir the colder oil to the surface. If the oil is viscous, a steam bubble froth also lends an assist.

FIGURE 6—Foam spray nozzle is being used effectively to blanket a pit (or pool) of low flashpoint oil.



"Special" in Every Way

Made entirely from Type 321 stainless steel, this unusual heat exchanger demonstrates The M. W. Kellogg Company's ability to engineer and fabricate such equipment to special as well as standard specifications. In this case, special welding procedures were developed, as well as special methods of seal-welding tubes to tube sheets; special machining of the tube sheet was required for each tube; and special techniques were employed for testing. Special in every way, this unit is scheduled for special service in an English oil refinery.

FABRICATED PRODUCTS DIVISION

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FIGURE 7—One of the most effective ways to roll colder oil from the bottom to replace the heated surface is injection of air into the bottom of a tank. Note the glob of air on the way to the surface of the kerosine. The one that went before carried enough cold oil to reduce the fire. The one shown above carried enough to finish it off.

fire will not continue to burn in a gas tight enclosure, the type fire on which such procedure could be used would be out anyway.

2. **Mechanical shut off of the air** such as closing of doors, covering of container openings, and blanketing of the surface, such as with foam. An attempt to cover as large an opening as a manhole or a tank truck dome by use of blankets or other such material is not recommended. It is safer to simply snuff out the fire by use of dry chemical or other inerting agent. The extinguishment of a tank truck dome fire can be done safely and easily, simply by pushing the dome cover down.

The blanketing of the surface of oil with foam is claimed by some to be extinguishment by a reduction of the vapor in the vapor-air mixture. It also cuts off air from contact with the liquid, and thus prevents the formation of the flammable mixture. Therefore, for convenience it is here classified as reducing air at the surface of the oil. (See Figures 3 and 4.)

How to Reduce Vapors. The chief method of reducing vapor is the cooling of the substance below the temperature at which it will produce vapors at a pressure to form a correct vapor-air mixture to continue combustion. It is obvious that substances, such as gasoline which at a very low temperature produce vapors at such pressure to form a burnable mixture, cannot be extinguished by cooling alone.

For fire fighting purposes, petroleum and its products can be divided on the basis of vapor pressures and whether the oil is on the loose or is at rest trapped in a pit, pool, tank or other container. As some oils can be more easily extinguished when contained, the following discussion will be divided into contained and uncontained oil fires and gas fires.

CONTAINED OIL FIRES

The contained oil fire is easier to control than the uncontained. It isn't going anywhere as long as it remains contained, which in the case of a product tank is until extinguished or the tank contents burn to consumption. These fires are also very few in number in correctly constructed tanks. Contained fires fall into two classifications, high flashpoint and low flashpoint:

1. **Contained high flashpoint** fires include:
   a. Burning oils, such as kerosine and other oils with flashpoints above normal temperatures and having little or no vapor pressure.
   b. High flashpoint oils error contaminated to formation of flamable mixture above the liquid surface.
   c. Petroleum solids (asphalts).
2. **Contained low flashpoint** fires include:
   a. Fires involving such products as gasoline, JP4 and other products stored in tanks, tank trucks, pits and pools.
   b. Low flashpoint crude oil in tanks.

The high flashpoint oil does not provide vapors at normal temperature to become ignited and the low flashpoint high vapor pressure oil (i.e., gasoline) provides too much vapor and thus keeps the vapor space near the surface of the oil too rich in vapor to burn.

Since these oils do not have vapor pressures, conservation vents or flame arresters on vents are not required on high flashpoint oil tanks. To serve their purposes, the oils under this heading must be spread in thin film as on a wick, atomized by special burners, heated to a temperature to cause them to set up a vapor pressure of .18 or more, or pressured and conditioned as in a diesel engine.

There is no problem of contained fires in oil of this nature except in the case of such products as kerosines in climates where temperatures may exceed the flashpoint of the oil. Fires that have occurred in tanks containing petroleum products with these characteristics have been few and far between.

In some cases fires have resulted from overhead pumping or through raised swing lines. A majority have occurred when pumping in from ship to shore and at the time the part of the water slug mixed with oil in turbulence is entering the tank. Sometimes the explosion which removed all or part of the roof consumed the light ends of the contaminating oil, without providing sufficient heat energy to produce other vapors in quantity to continue to feed the fire. In at least one case pumping in agitation extinguished the fire.

How to Extinguish Contained Fires. The low flashpoint contained oil fire is extinguished by reduction of air only and the small high flashpoint contained oil fire can be more easily and quickly extinguished by this method. Therefore, extinguishers that reduce the air content such as dry chemical and Co_2 are prevailing, especially in refineries.

Small and large tanks of both high and low flashpoint oils can be extinguished by blanketing the surface of the oil with fire foam. As fixed foam installations are very

Why Suffer with Sulfur?

Less sulfur in the refinery stream means less corrosion and gum formation in process equipment . . . lower investment costs . . . less contamination of catalysts . . . less antagonism toward TEL . . . improved product odor, color, and stability . . . more profit in many ways for both the refiner and marketer.

Kellogg has the economic answer to high sulfur crudes. Working closely with the refiner's engineers, as it has done with those of leading oil companies on the East and Gulf Coasts—as well as in England, Belgium, France—Kellogg can design a unit to remove harmful sulfur compounds to almost any degree desired. In one typical instance, weight per cent was reduced from 0.84 to 0.08 in catalytic gas oil, and from 0.66 to 0.05 in furnace-oil distillate.

Optimum investment and operating costs are assured through designs that utilize selectively lower pressures, reduce the use of costly alloys such as 18-8, and lower the consumption of high pressure hydrogen.

Kellogg desulfurization units can be engineered to treat virgin streams of naphtha, kerosene, gas oil and other fuels, and cracked stocks of similar boiling ranges. Or units can be designed to operate simultaneously on streams from the topping and cracking units. Where desired, the design can include equipment to recover the sulfur as a salable by-product. Your inquiries will receive prompt attention.

REFINERY PROCESS DIVISION

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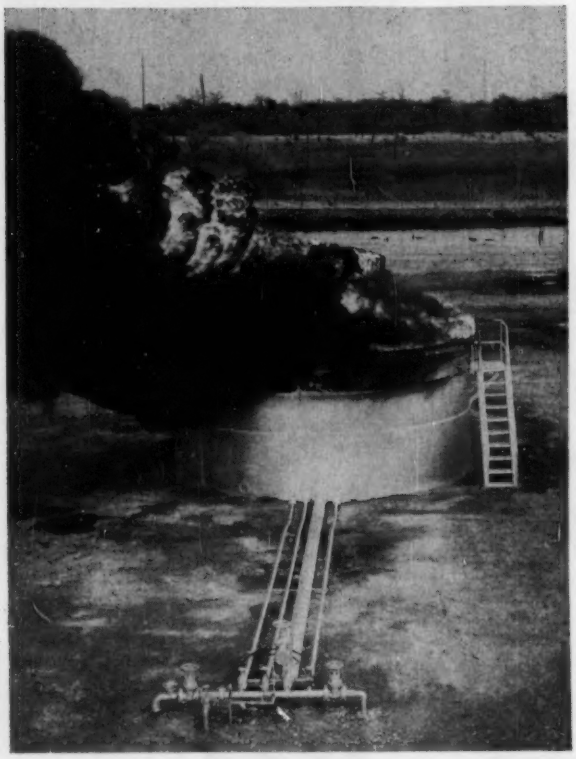
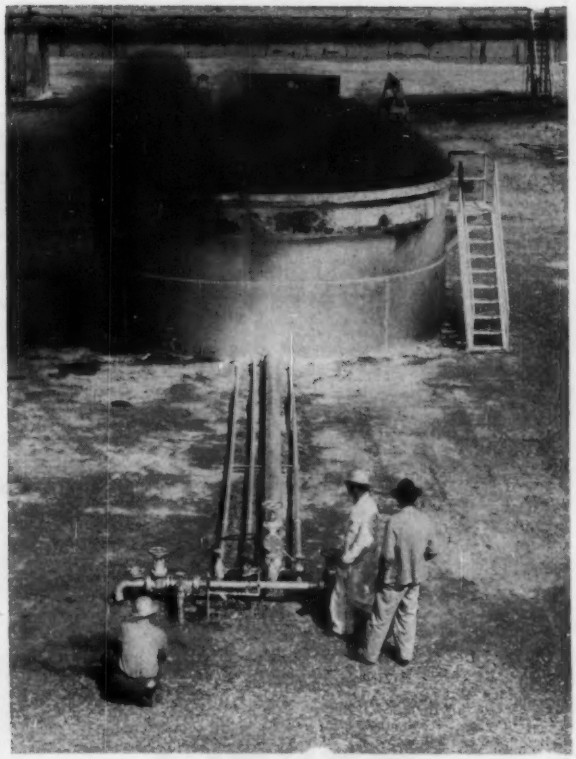
For more data on advertised products, use Readers' Service Cards, last page.





FIGURES 8 and 9—The 20 ft. diameter tank at left contains a mixture of 95 percent fuel oil and 5 percent gasoline. At right, the same tank fire is shown being put out quickly by air agitation, after eight minutes of burning. After the fire, the oil weathered back to high flashpoint oil characteristics.

often disrupted when the tank roof is blown, perhaps portable equipment provides the surest working devices. (See Figures 3 and 4).

The high flashpoint contained oil fire can also be extinguished by reduction of vapors to below the percentage required to form a flammable mixture by cooling out the heated thin surface layer that is providing vapors to feed the fire. This can be done in pit, pool or in a small tank by use of water spray. This cooling method will not extinguish the fire in vapors from such low flashpoint oils as gasoline. However, very viscous low flashpoint oils can sometimes be extinguished by creating a froth on the surface with a spray or stream of water.

A pit or pool of high flashpoint oil can also be extinguished by digging a stream of water into the surface in a manner to stir the cooler oil from below to replace the heated surface. (See Figure 5.) This cannot be done in the case of a pit or pool of gasoline. A simple method of extinguishing the large pit of gasoline is by starving and smothering the fire with a blanket of foam. The large foam spray nozzle is an effective weapon with which to apply the foam without knocking the oil out of the pit or breaking up the foam blanket. (See Figure 6.)

Small pits or pools of both high and low flashpoint oils can be extinguished by small dry chemical extinguishers. Larger pits and pools, and spills of high and low flashpoint oils, can be extinguished with the large type dry chemical units.

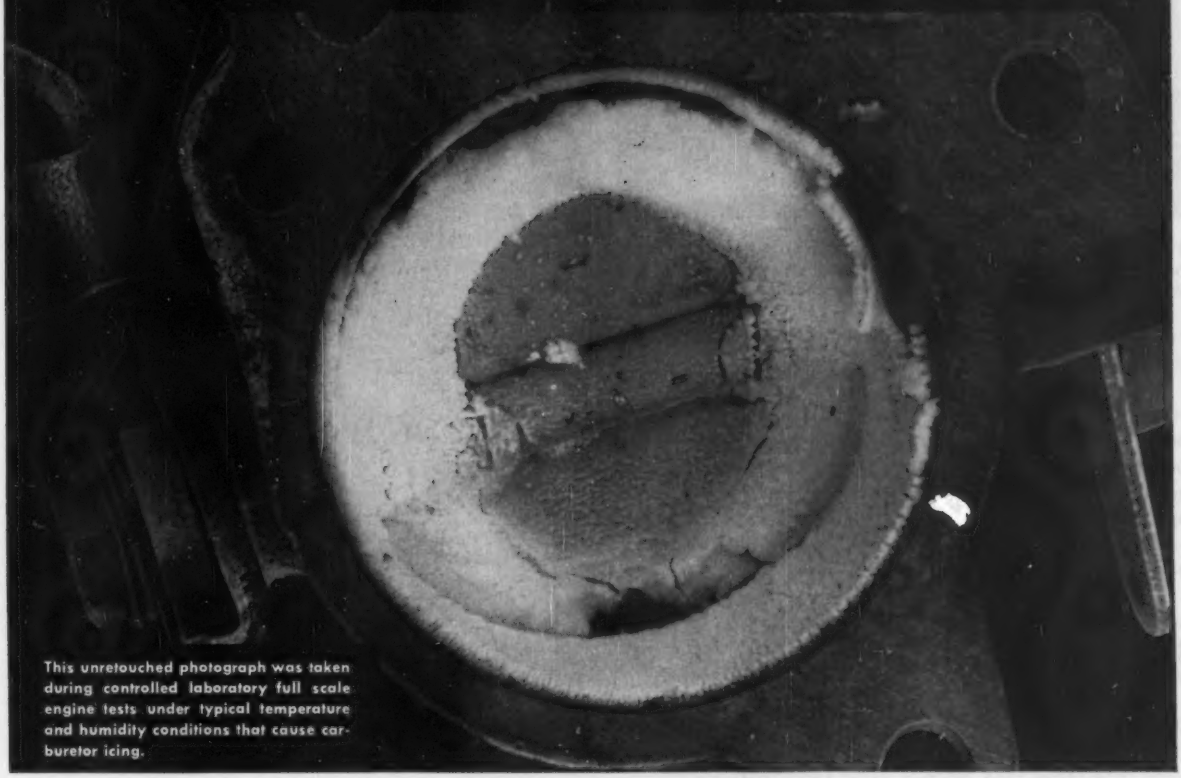
It has been noted by test that the capacity of dry chemical extinguishers or units, when used on high flashpoint oil, is three times that of the same size extinguisher or unit when used on a low flashpoint oil such as gasoline.

The large or small tank—contained oil with a flashpoint above storage temperature can be extinguished rapidly by rolling some of the colder oil from below to replace the heated surface. (See Figure 7.) Perhaps the most practical method of doing this is by injection of air into the bottom of the tank. The air expands, and on its way to the surface pushes and entrains the colder oil to the surface.

In the case of refined oil, the heated surface layer of oil never goes deeper than two inches below the surface regardless of how long it burns. Therefore, air agitation is a quick method of extinguishing a high flashpoint product tank fire. In the case of high flashpoint crude oil the agitation must be done before the heat wave has penetrated too deep into the surface of the oil. (See Part 3, March 1957.) A special film on the air agitation method titled, "Beneath the Flames," is available from Socony Mobil Oil Company.

Millions of gallons of gasoline are stored in all steel gas tight adquately vented tanks. These standard tanks have been in use over a long period of time, and where so maintained there is no record of a gasoline tank fire in one of these tanks. In groups of as high as two thousand large modern standard tanks containing the differ-

If this happens will your gasoline take the blame?



This unretouched photograph was taken during controlled laboratory full scale engine tests under typical temperature and humidity conditions that cause carburetor icing.

Save That Customer! UNICOR®-LHS PREVENTS CARBURETOR ICING

If carburetor icing happens to stall the car of one of your customers this winter he'll probably cuss out your gasoline, rather than the temperature and humidity conditions that are the real culprits. Keep him happy, and his car rolling, by treating your product with UOP's anti-icing compound, Unicor-LHS. This is a completely new compound, the most effective anti-icing agent yet developed. It is easy to apply and economical to use. Here are its advantages:

Most potent anti-icing agent: Unicor-LHS is an anti-icing agent, not just a de-icer. It prevents ice formation and is about 40 times as effective under severe carburetor icing conditions as the widely-used alcohol type.

No gasoline dilution: Because it is used in very low concentration Unicor-LHS causes no significant loss in BTU value of gasolines, a primary disadvantage of ordinary de-icing compounds.

Convenient and economical: Only small amounts of Unicor-LHS are required . . . less than half the cost of alcohol. No large scale storage or blending facilities needed. It can be applied anywhere from refinery to jobber or filling station.

Not water soluble: Not soluble in water, Unicor-LHS (light hydrocarbon soluble) is completely and instantly miscible in even the lightest components of high vapor pressure winter-grade gasolines.

Available right now: Write our Products Department for samples or for commercial quantities. We'll be glad to advise you on the most economical way to use Unicor-LHS.

Unicor-LHS is also an effective rust and corrosion preventative. Protects refinery processing equipment, distribution and storage facilities all along the line from the refinery to the final distribution point.

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More Than Forty Years Of Leadership In Petroleum Refining Technology

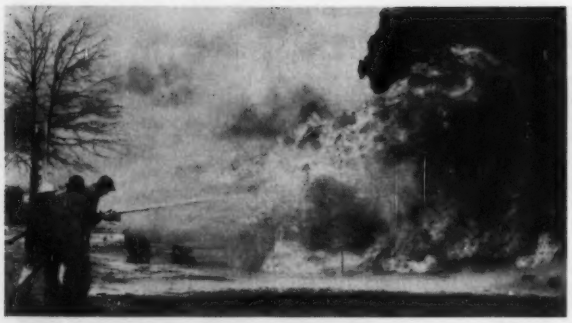

FIGURE 10—In the tank truck fire above, the running channels of burning oil were covered by foam and the three dimensional fires were extinguished with dry chemicals.

ent petroleum products the records show no tank fires during the past 30 years.

However, gasoline tank fires have occurred in incorrectly constructed or maintained tanks. Also, fires have occurred in correct tanks in low vapor pressure low flashpoint oils. These fires in large tanks cannot be extinguished by cooling alone or with the usual air diluting agents because of no effective method to date of application. Therefore, these fires are usually extinguished by blanketing the surface with foam.

The high vapor pressure of the gasoline vapor is a safety feature of gasoline. After the fire occurs, however, the higher the vapor pressure the more difficult the fire is to extinguish.

Although air agitation alone will not extinguish the low flashpoint oil fire, it will so reduce the flames as to make the extinguishment of the fire much easier with foam in a large tank or in a small tank with dry chemical or foam.

The tank truck dome fire is a simple contained fire. These fires in tank trucks containing high flashpoint oil are difficult to kindle, since this oil does not ignite in bulk at normal temperature.

A contained dome fire can occur when low flashpoint oils such as gasoline are in the tank or tank truck. This type fire is easy to extinguish by simply closing the dome cover. These gasoline fires can also be extinguished easily with dry chemical or CO_2 extinguishers.

High Flashpoint Oil Error Contaminated with Low Flashpoint Oil. The question might be asked, "Why is a tank of high flashpoint oil error contaminated to form a flammable air-vapor mixture above its surface in a container not classified as a low flashpoint oil?" This might be for fire prevention, but not for fire fighting. A special study has been made of fires in tanks of error contaminated oils. In some cases all of the light ends of the contaminant have been consumed in the initial explosions leaving the oil in the tank with a flashpoint and vapor pressure that would classify it well within the category of a high flashpoint contained oil fire. In other cases where the oil continued to burn after the explosion the light ends quickly burned away and returned the high flashpoint oil to its approximate original flashpoint and vapor pressure.

In a series of tests using a 20-foot diameter tank it was found that in the case of No. 2 fuel oil with a flashpoint of 150 F. temperature that 5 percent gasoline contamination was weathered to near the approximate characteristics of the fuel oil in eight minutes after ignition. One of the purposes of this test was to determine the time required for the light ends of a 95 percent No. 2 fuel oil—5 percent gasoline mixture to burn away and enable extinguishment by the same methods as would be used to reduce the vapor by cooling to below the flashpoint of the liquid. The air agitation method of rolling colder oil from below to replace the heated surface was to be used.

The No. 2 fuel oil was pumped into the 20-foot diameter, 9½ foot high tank to a depth of 7 feet including a 12-inch water bottom and leaving a 2½ foot free board. Analysis of the two components of the mixture follows:

#2 Fuel	Gasoline
Gr. = 27.4 API	62.2 API
Fl. = 212 F.	—45 Deg. F.
RVP = 0	9.0#

#2 Fuel	Distillation	Gasoline
431 F.	IBP	100 F.
478 F.	10%	126 F.
539 F.	50%	200 F.
605 F.	90%	306 F.
636 F.	99%	
	EP	398 F.

The mixture was stirred by air agitation to result in a mixture with analysis as follows:

Gr. = 28.9 API
Fl. = Below room temp.
RVP = 1.0#
BS = Trace

Distillation
194 F. IBP
440 F. 10%
536 F. 50%
602 F. 90%
630 F. 99%

The tank was ignited and after a pre-burn of five minutes was extinguished in one and one-half minutes by foam application. The foam was quickly pushed from the surface and the tank re-ignited and allowed to burn two minutes when it could be easily extinguished by air agitation. Immediately after extinguishment a sample was taken. The change in analysis of the oil after burning was striking as shown by analysis of the tank contents before and after burning:

Before	After
Gr. API = 28.9	27.4
Fl. = Below room temp.	210 F.
RVP = 1.0#	—1#
BS = Trace	0.1%

Before	Distillation	After
194 F.	IBP	446 F.
440 F.	10%	485 F.
536 F.	50%	540 F.
602 F.	90%	605 F.
630 F.	99%	634 F.

It may be seen from the above comparison that there is a great difference between a product with a flashpoint below storage temperature and a product with a flashpoint above storage temperature that has been contami-

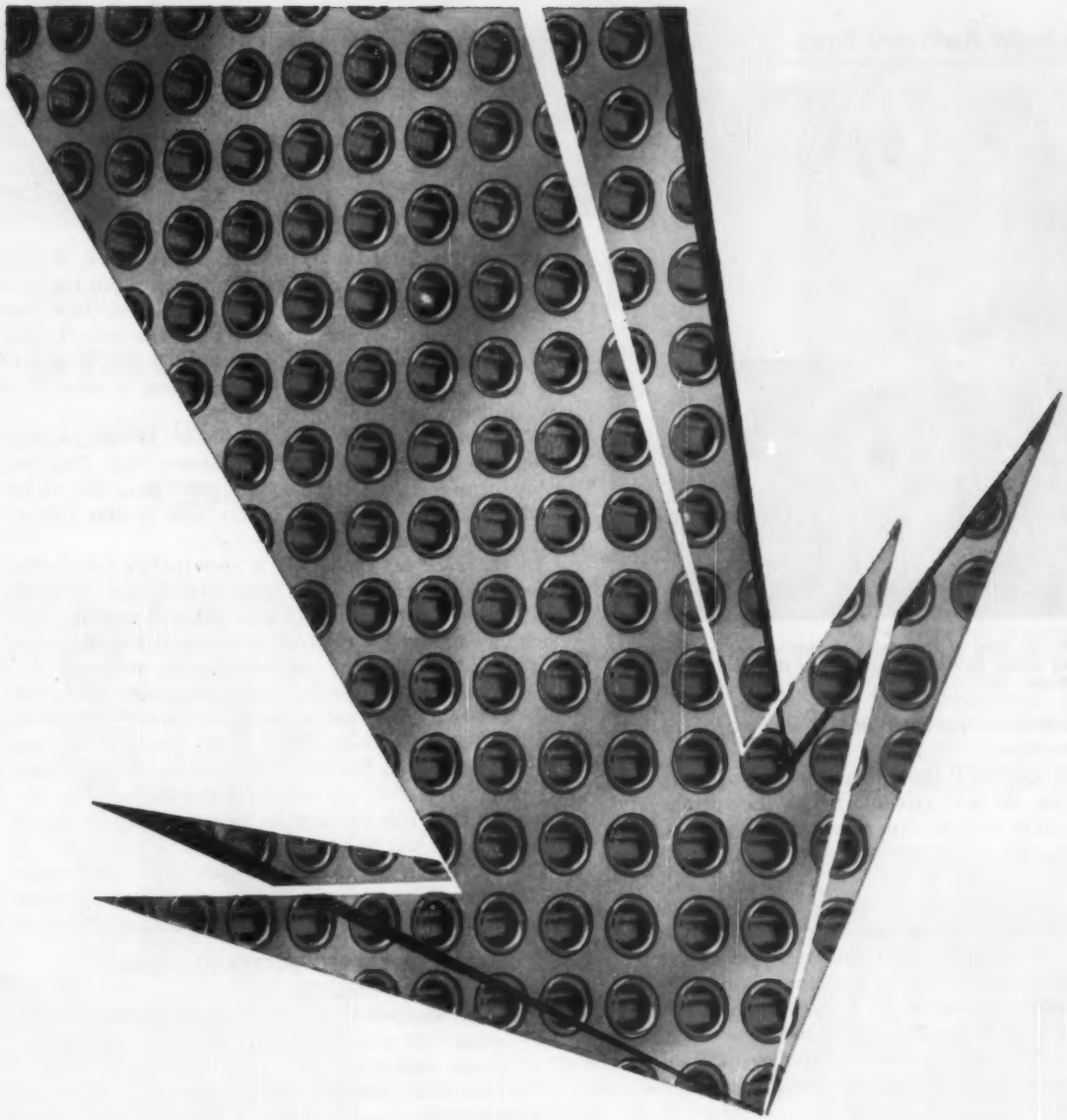

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FIGURE 11—As long as the water stream is kept on the paper covered wood panel, neither the paper nor the wood is damaged by the gas flame.

nated sufficiently to provide ignition at the surface, or in vapor space above.

It is also indicated above that the light ends of the contaminating oil will rapidly rise to the surface and burn off quickly, with or without agitation, but will burn off more rapidly in comparison with heat input when agitated.

Error-contamination is not likely to exceed 5 percent without being detected and corrected. Therefore, it was concluded that should a fire occur in a tank containing oil with a flashpoint above storage temperature that had been error-contaminated so as to become ignitable, the light ends would burn off and the fire be extinguished by air agitation alone, or by other cooling methods, before portable equipment could be brought to the scene from a distance.

These tests, and previous tests with contaminated kerosine, indicate that high flashpoint error-contaminated products can usually be extinguished by cooling in the same manner as before contamination. However, the length of time required for extinguishment varies with the percent contamination and length of burning time.

It also appears that the higher the flashpoint and the lower the vapor pressure of the oil contaminated, the more quickly will the light ends of the contaminant be weathered out by burning. (See Figures 8 and 9.)

Pre-Burn of Petroleum Products. How does long burning affect the extinguishing methods of contained refined oils? The answer is, it doesn't. Why? Because in the case of petroleum products surface burning does not cause a rise in temperature deeper than two inches below the liquid level, regardless of how long it burns. Therefore, the length of time that a refined oil tank has burned at the surface makes no difference in the fire fighting method.

Regardless of how long it has burned, when foam or water is applied to the burning surface of refined oil, the very thin heat layer is not deep enough to expand it until it spills the oil over the side of the tank, and the fire is extinguished without slopover.

This is not to be confused with the slopping out of the oil when foam or water is applied to a heavy refined oil, the quantity of which is heated to well above the boiling point of water before the fire starts, such as in the case of heavy fuel oil and asphalts heated to pump.

Petroleum Solids. These fires are classified as high flashpoint petroleum fires although they are not really in the flammable or combustible class. Chief of these fires is heated asphalt in small tanks. This substance, heated in order to pump it, is sometimes accidentally heated to above its flashpoint, which in some cases is near or at its ignition temperature.

Most petroleum products cannot be heated to their ignition temperatures in open containers. Since they boil away before reaching this point, products such as asphalt, petroleum, coke and others with similar characteristics are exceptions.

In the case of asphalt, it is inevitably pre-heated throughout when the tank takes fire. It can be easily extinguished with foam or water, but will slop over and create a considerable clean up problem. If foam or water is applied sparingly the slopover may be reduced.

There are claims for certain wetting detergents that they will enable the use of water on asphalt fires without causing a slopover. There is no question but that water applied as a fine fog will cause less slopover than a stream of water. Of course, if dry chemical or dry steam or CO_2 can be used and fire held down against re-flash, there will be no slopover.

Due to the viscosity of these solids even when warm, air agitation is not recommended, except with extreme precaution against pushing the burning oil from the tank.

UNCONTAINED PETROLEUM FIRES

Uncontained oil fires include:

a. **High flashpoint** oils such as kerosine, fuel oils and other oils with flashpoints above normal atmospheric temperatures.

b. **Low flashpoint** oils such as gasoline, JP4 and other petroleum flammable liquids below normal atmospheric temperatures.

Where possible, an early step in fighting an uncontained fire is to stop the flow of fuel to the flames. Water fog provides an excellent screen behind which to approach the fire and close the valve. Also, certain types of suits are provided for protection of the man from the heat while closing valves or rescuing persons. Make sure that the suit provides the protection before permitting the man to take a chance.

Another method of stopping the flow of fuel to a fire is by replacing the flow of oil with water. For instance, a gasoline fire at a broken tank line. Assuming the valve cannot be closed, what can be done? It is well known that petroleum products will float on water. So water can be put into the tank to raise the oil level above the outlet line. Then water flows from the broken line instead of gasoline. The spilled gasoline can be washed away to enable the closing or fixing of the valve or line in safety. Make sure when using this method that the container is not overflowed.

The way to fight an uncontained fire also depends on

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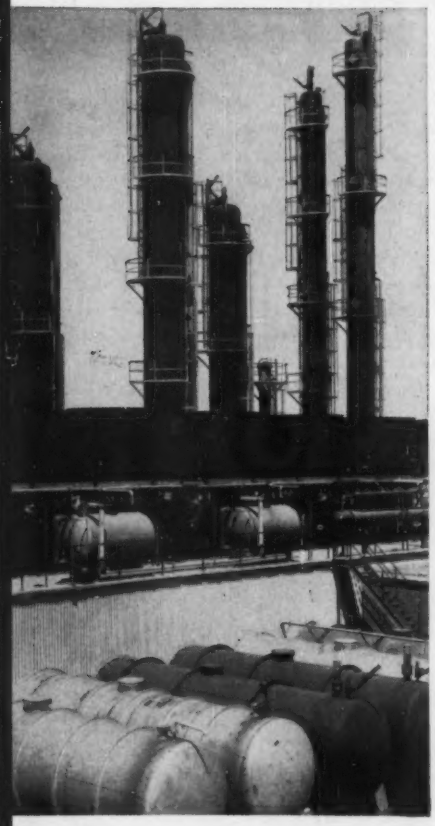

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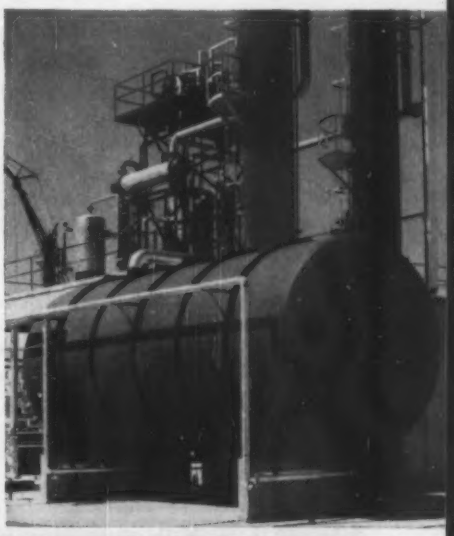

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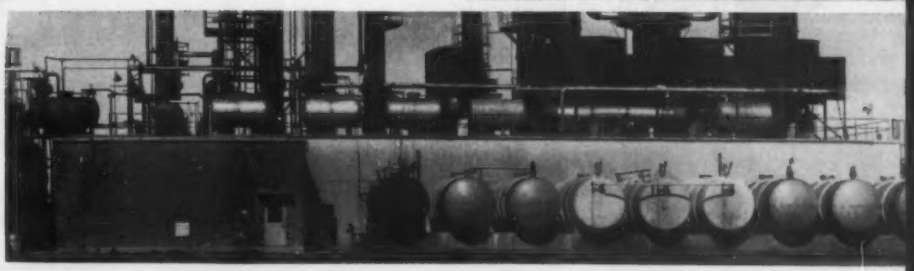

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whether the fuel has a high or low flashpoint. A flowing high flashpoint product, i.e., fuel oil, is difficult to ignite unless it is exposed to a considerable amount of flame. And the fire does not travel back up to the source of the oil over the unheated flowing oil. The ground fire can be extinguished by the cooling effect of water.

By comparison, an uncontained gasoline fire travels quickly up to its source. Water spray is ineffective in reducing the abundant supply of gasoline vapors sufficent to extinguish the fire. However, the spray protects the fire fighters and cools the steel. The fire is then put out by smothering and starving it with dry chemical.

Many illustrations could be given of how an uncontained fire can be extinguished by cooling with water with either stream, fog or foam, and how the same type of fire involving low flashpoint products can not be extinguished by reducing the vapor alone by cooling. When such fires are so extinguished, the agencv is made to expel the air to a reduction which breaks up the flammable range.

Combination Contained and Uncontained Fires. In the case of a high flashpoint contained and uncontained fire the running oil is easily cooled to extinguishment and then the contained fire handled in turn. In fact, the general rule in the case of either high or low flashpoint oil is to handle the uncontained fire first.

When a low flashpoint uncontained fire is combined with a contained one the fire quickly travels upward to the source of the gasoline. There is no danger of an explosion in the top container and there is no hurry to put it out. If you start at the top, the extinguisher may empty itself before the lower fire is reached. If it does, the fire quickly travels up to the source of the fuel again.

But, if you start at the lower fire, the upper fire will not re-ignite it because its vapors are being burned off as they leave the surface, and the vapors of the lower oils are dropping to the ground and do not become re-ignited by the upper fire. So the principle is to put out the lower fire first—then extinguish the upper one.

The same principle applies to a tank truck dome fire with surrounding ground fire.

Use of water in the form of spray and dry chemical provides a very effective combination, especially in the case of a running fire in which steel or wood, and oil are involved. In this case swing on the water for cooling of steel or extinguishing of wood; swing off the water then swing on the dry chemical quickly to extinguish the oil fire. Finally, swing the water back on to prevent re-ignition.

In refinery units and similar structures, if proper drainage is provided, an excellent method is to close the valve and stop the flow from the broken line or connection, then deluge the skin oil fire down through to the sewer trap.

Streams of burning oil, even low flashpoint, can also be covered with foam so that the oil flows under, but flames are stopped. These localized flames can often be extinguished by dry chemical. Tank truck fires have been successfully handled with this method.

Control of Liquefied Petroleum Gas Fires. Liquid petroleum gas is held in liquid form by its own vapor pressure. This pressure is dependent upon the temperature just as does the vapor pressure of liquid petroleum products. The chief constituents of this gas are butane and propane.

At 60 F. propane has a vapor pressure of as high as 70 psi, while at the same temperature butane has a vapor pressure of only 17 psi. These two are usually combined to form a product which when released from this pressure rapidly becomes vapor, which then in turn is mixed with air to take the form of a useful fuel.

With such vapor pressures it is obvious that these gases cannot be extinguished by cooling. The flammable range of this product is dependent upon the mixture, but the range will never be greater than 1.9 to 9.5 parts vapor mixed in volume with from 98.1 to 90.5 parts of air.

The flashpoint of this gas is too low to be of any significance. The high ignition temperature of petroleum gas is a safety feature from ignition, that of propane being 871 F. and that of butane, 806 F.

Even in enclosures only the light ends are held in the liquid gasoline by its vapor pressure, the vaporization is slow and the vapors are well diffused with the air as they come from the spilled liquid or over the edge of the open container. Liquefied petroleum gas is different. The Liquid petroleum gas and natural gas are vapors pressed into liquid. When these bonds are broken they issue forth as almost pure vapor which expands into the air and is pushed by it as a cloud. The vapor will therefore travel, still in flammable concentration, many times as far as vapors from gasoline.

A heavy quantity of the liquid released will form a vapor that has been known to travel as far as 5000 feet while vapors from open surfaces of gasoline have not been known to travel a greater distance than 150 feet.

The gas fire is a special type of uncontained fire. Where the burning jet is hitting a fuel line, tower, or other structure, a useful device is to protect the surface with a cooling stream of water. (See Figure 11.)

If a container of liquefied petroleum gas is exposed to heat the pressure inside will increase. A stream or spray of water will retard the build-up of pressure to the extent of usually even preventing the safety plug or valve from releasing. But, stand to one side and away from the cylinder to prevent being struck by a jet of flame should the safety plug blow out or the safety valve release.

The gas fire can usually be extinguished easily by use of dry chemical. This should not be done, however, unless the valve can be closed immediately after extinguishment. If the gas continues to flow it spreads over a wide area, and re-ignition makes en even bigger and much more hazardous fire. In a confined area the fire could be an explosion.

Where possible it is preferable to extinguish a gas fire by closing the valve first. The fog protects the man from the heat. Many serious burns have resulted from gas flash-backs in cases where no hazard would have been present had the fire been permitted to continue to burn. It is more important to know when not to put out a fire than to know the details of the actual extinguishment. In all events, immediately get cooling water on metal involved in a gas fire.

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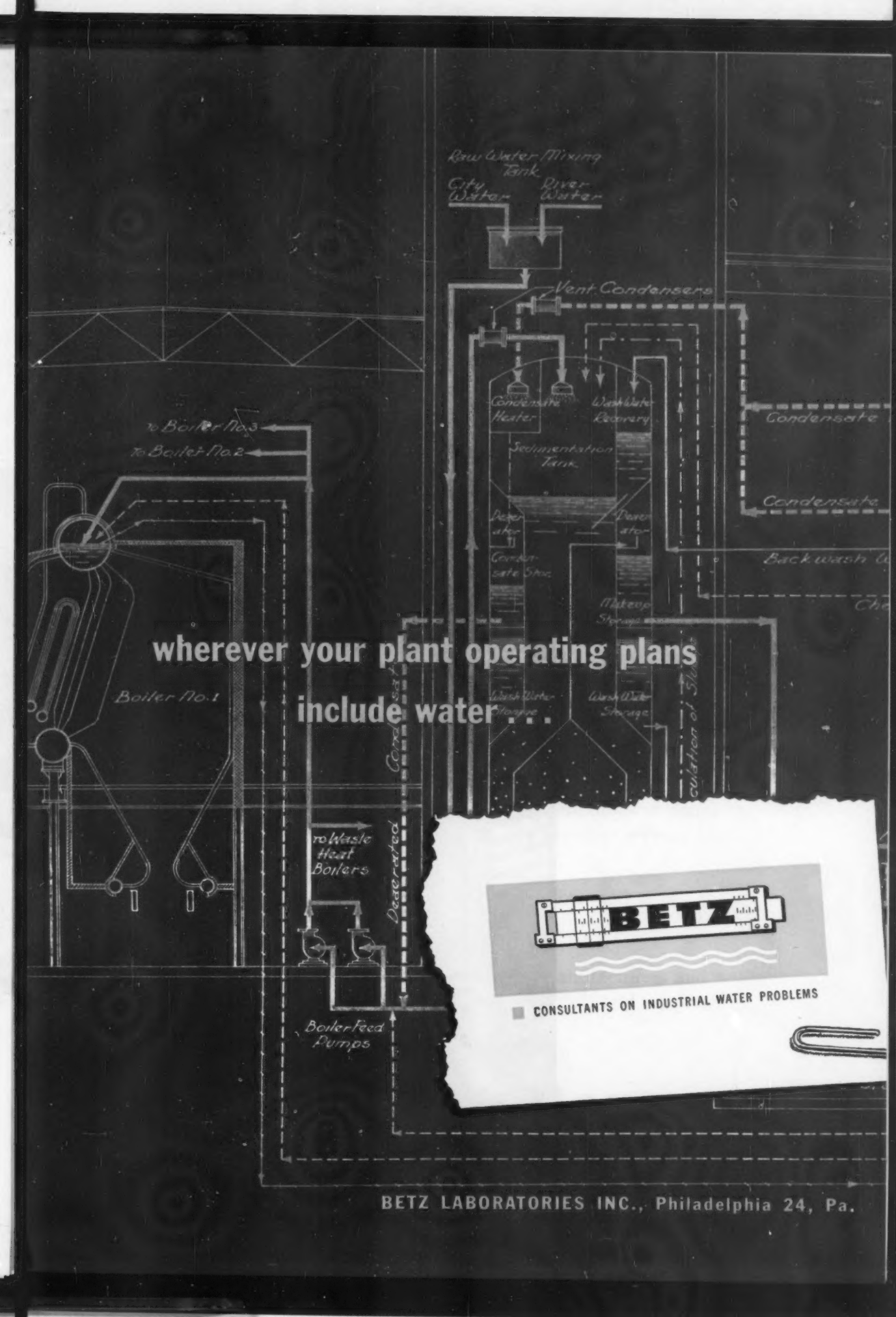

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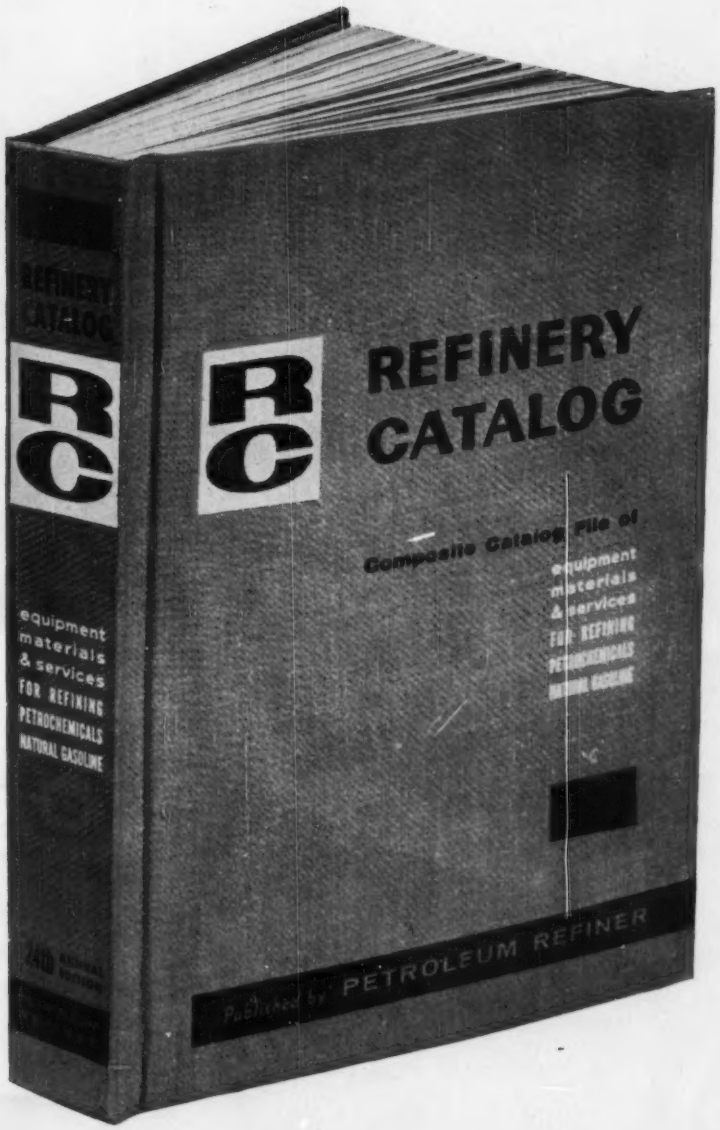

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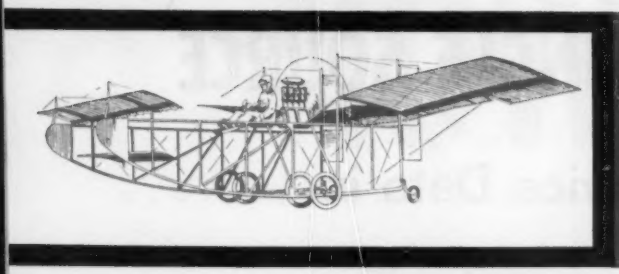

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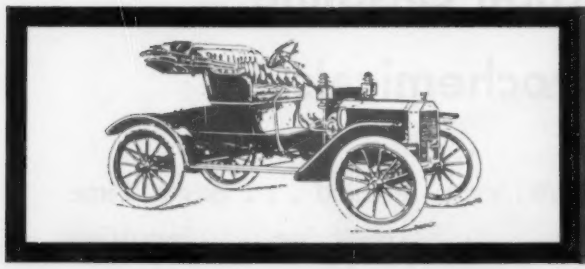

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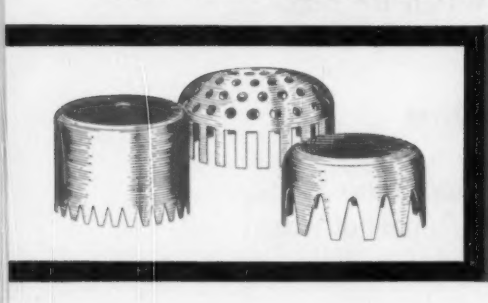

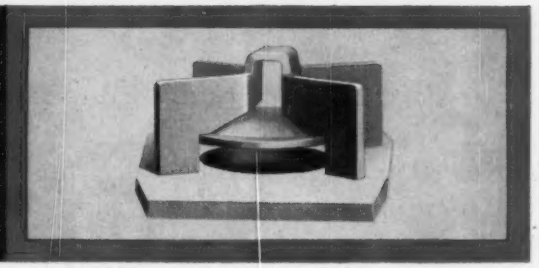

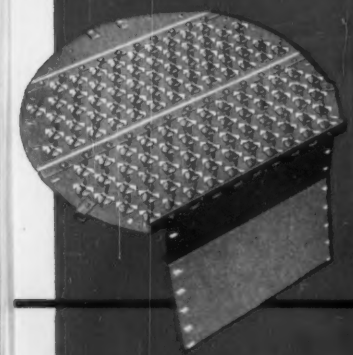

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What's Happening . . .

. . . in the Industry

What's Ahead for the Next 10 Years?

Look for a slower rise in domestic demand with some changes in product distribution.

(This lead article consists of excerpts from a paper presented by Albert J. McIntosh to a session on petroleum statistics during the annual meeting of the API in Chicago. McIntosh is an economics consultant for Socony Mobil Oil Co., Inc., New York.)

DOMESTIC DEMAND (Table 1) for all products in 1958 may increase by 2.6 percent, which isn't too bad in itself, but this small increase follows a disappointingly low increase for this year. You have to go back to the great depression years to find two such poor years in a row.

Included in this total is an increase for all gasolines of 3 percent. This seems rather modest compared with the yearly average increase of 6 percent since the end of World War II. These percentage increases though, are becoming harder to maintain as each percentage point represents a very large volume. It is worth noting that the increased *volume* of gasoline sales anticipated for 1958 is greater than the increases obtained in 1957, 1956 or 1954 and is about the same as for 1949.

TABLE 1
Demand for Petroleum Products Estimated 1957 and Forecast for 1958
(Thousands of Barrels Daily)

	1957 Estimated	1958 Forecast	CHANGE FROM 1957 Volume	Percent
Domestic Demand—U. S.				
Gasoline	3,835	3,950	115	3.0
Middle Distillates	2,037	2,085	48	2.4
Residual Fuel Oil	1,523	1,523	...	...
All Other Products	1,516	1,585	69	4.6
* Total Domestic Demand—U.S.	8,911	9,143	232	2.6
Exports from U.S.	565	299	(266)	(47.1)
Total Demand U.S.	9,476	9,442	(34)	(0.4)
*Free Foreign Countries	7,187	7,823	636	8.8
Total Free World (a)	16,098	16,966	868	5.4

(a) Total of above lines marked *

Middle Distillates Up Slightly. For middle distillates we are looking at a total of 2 million barrels a day or 2.4 percent over last year. The railroads are pretty well dieselized and new home building has slowed a bit. Gas and electricity are most aggressive competitors in home heating and we can't expect much of an increase for oil in this market.

Diesel tractor fuels should continue their long-time upward trend, but industry will probably not be in the market for much more middle distillates due to its retarded operations during 1958. Normal weather was assumed for next year.

Moving Sidewise. Industrial fuel, or residual fuel oil as we call it, we think will move sidewise. Most domestic producers have continued to minimize the production of this product, and over the years the demand has been met by changes in imports. Such imports have supplemented domestic supplies generally to provide only sufficient additional product to take care of the total demand. If customers need more of this product, it can always be made domestically or imported.

Jet fuel, of course, will boom right along. The military will take most of it, but it won't be long before domestic and international airlines

TABLE 2—United States Demand for Petroleum Products
1927-1937-1947-1957 and Forecast for 1967
(Thousands of Barrels Daily)

	TOTAL PRODUCTS			GASOLINE			MIDDLE DISTILLATES			RESIDUAL FUEL OIL			ALL OTHER PRODUCTS		
		Change From Prior Period			Change From Prior Period			Change From Prior Period			Change From Prior Period			Change From Prior Period	
Year	Volume	Volume	Percent	Volume	Volume	Percent	Volume	Volume	Percent	Volume	Volume	Percent	Volume	Volume	Percent
1927	2,201	1,285 E	140	837	683 E	443	N.A.	N.A.	..	N.A.	N.A.	..	N.A.	N.A.	..
1937	3,203	1,002	46	1,423	586	70	471	193 E	69	892	137 E	18	417	86 E	26
1947	5,452	2,249	70	2,178	755	53	1,098	627	133	1,421	529	59	755	338	81
1957	8,911	3,459	63	3,835	1,657	76	2,037	939	86	1,523	102	7	1,516	761	101
1967	12,650	3,739	42	5,450	1,615	42	2,700	663	33	1,675	152	10	2,825	1,309	86

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INDUSTRIAL OIL BURNERS, GAS BURNERS, AND FURNACE EQUIPMENT

What's Happening . . .

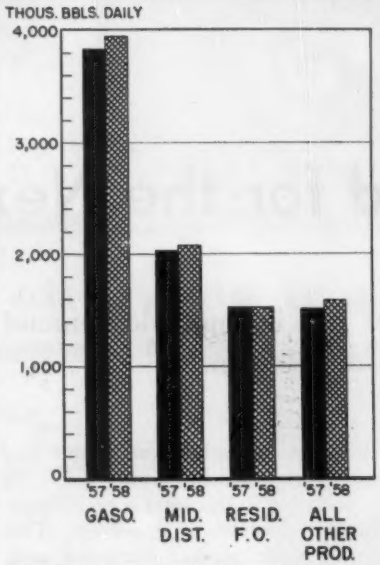

FIGURE 1—Domestic demand for petroleum products.

will need a great deal. Jet fuel may increase about 8 percent in 1958.

As for Everything Else. All the rest of the products—lubricants, wax, coke, road oil and asphalt, liquefied petroleum gas, still gas, petroleum portions of petrochemicals and miscellaneous sundries, may account for 15 percent of the barrel next year and increase a good 4.1 percent. The first three of those listed will probably show little if any change year to year but some of the latter seem to be growth products.

All of these things you probably know, but it is nice to have someone confirm your opinions.

Table 2 shows the U. S. domestic demand at each 10-year interval. I think we should be more concerned with volume changes than percentage changes. We have to discover, refine, transport and deliver gallons and a billion gallons increase requires just as much new equipment and oil in 1958 as it did in 1928. Nevertheless, I also have shown the percentage changes.

Volume Increase. You can see that the total volume increased tremendously in the decade ending in 1927, but naturally it slowed its climb during the depression years. In spite of the war the demand grew rapidly during the next decade to 1947, but it has been during the last 10 years that we have had our greatest growth.

Let's look at these same totals broken down into major products classifications. We find that gasoline increases have been more uniform than increases for all products. Also, during the last ten years gasoline sales increased more than double that of any prior decade. For the middle distillate category, we see a completely different picture with each decade putting to shame the prior smaller increases.

Residual fuel demand shows a different picture with the big increases coming in the 1937-1947 decade. The changes in the "All Other" products group follow the trend of the middle distillates. These are the past trends. If we were to look into the future we would find that the "All Other" products are expected to show the greatest rate of growth for any of the major classifications.

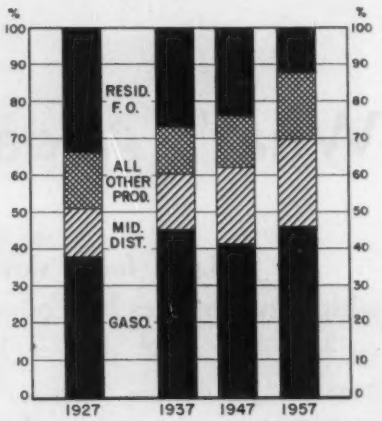

FIGURE 2—Relative Product Demand supplied by U. S. refineries or natural gasoline plants.

Domestic Demand. Another interesting sidelight from these data is the composition of the total domestic demand. In Figure 2 we have excluded that part of the demand supplied from imports. We therefore arrive at data reflecting customers' needs supplied by United States refiners or natural gasoline plant operators. The percentages are very much like our commonly used percentage yields, but they are not quite the same. From these data expressed as percentages we find the following interesting facts:

Gasoline's importance increased during the depression decade, slid as a result of the war and came back again during the latest 10 years.

Middle distillates, as we all know, have shown a steady climb versus other products—almost doubling their relative position since 1927. Residual continues its long-time slide and is only about one-third as important as it was in 1927 with the last 10 years showing a halving of its 1947 relative position. Just to re-emphasize it, I point out that this refers only to the residual fuel oil coming from domestic refiners. Other products moved upwards to any extent only during the last decade with liquefied petroleum gas being the principal product of strength.

What's Ahead. I am sure you would be disappointed if I stopped right here and didn't give you some idea of where we may be headed after 1958, so here goes.

Our economics department has again given me its best guesses for 1967—ten years hence (Table 2). In that year total demand may reach 12.85 million barrels a day or 3,375,000 barrels a day more than this year's approximation. This means a 337,000 barrels growth for an average year. Another way of thinking about the 1967 volume is that by that year we will have to be taking care of twice the product we handled around 1950.

In these 17 years the industry should double its rate of finding crude or shale oil reserves, either domestically or abroad, and in addition, it will have to about double its known domestic reserves to

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Q. Why has the price of gasoline gone up in the past 5 years?

A. **Like everything else, gasoline has gone up in price–but very little. Big boosts in gasoline quality have more than made up for the small increase in price. And, of course, taxes on gasoline have gone up, too.**

Q. Just how much are these gasoline taxes?

A. **Direct taxes–Federal and State–now add 8.9¢ (national average) to the price of every gallon of gasoline. This adds 40¢ to every dollar spent for today's gasoline.**

Q. And how much has the price of gasoline gone up?

A. **The actual price of the gasoline itself has risen less than 6% in the past 5 years. Compare that with the price increases on other items you buy every day.**

Q. What are these big boosts in gasoline quality?

A. **Well, today's "regular" gasoline is as good as "premium" gasoline was just 5 years ago.**

Q. And what about today's "premium" gasoline?

A. **Today's "premium" is as powerful as fighter plane gasoline at the end of the last war.**

Q. Why do I need these "higher-powered" gasolines?

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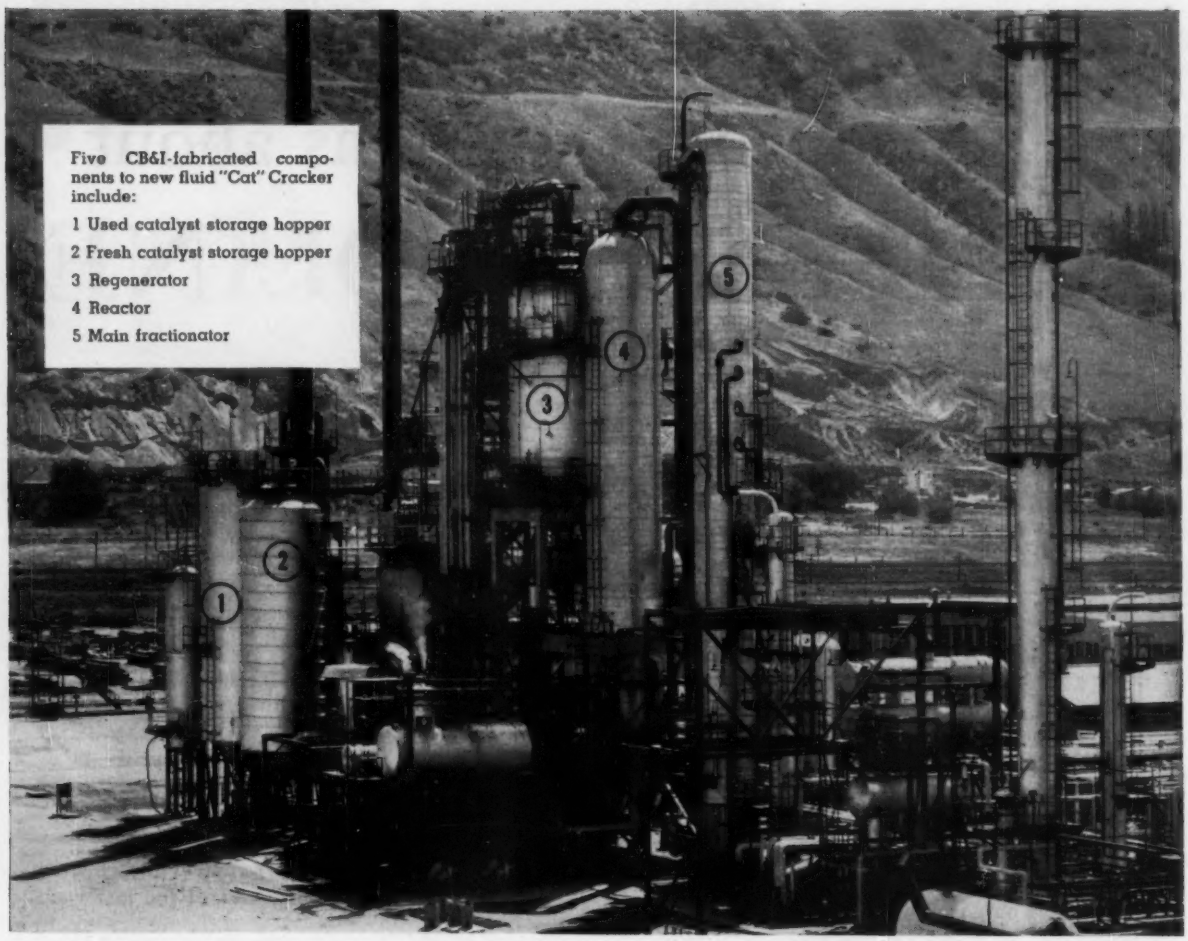

3 FOLD Expansion served by CB&I Structures

new "Cat" Cracker boosts Salt Lake Refining Company gasoline output by 20%

Included in the most recent expansion program of the Salt Lake Refining Company were CB&I-fabricated components for the new fluid catalytic cracking unit shown above.

The new "cracker", furnished through Fluor Corporation, has boosted gasoline output by 20%. The building of additional Horton® Floating Roof tanks now brings Salt Lake's storage capacity to more than 1,600,000 barrels.

Whether *you're* building new, or adding to . . . the *complete* facilities for design, fabrication and erection offered by CB&I can meet your most *specific* needs for petroleum storage or processing structures. Write for details.

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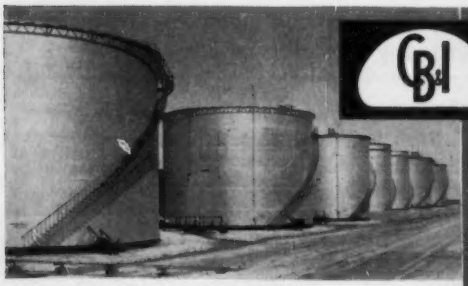

These Horton Double-Deck Floating Roof tanks are some of the 63 CB&I tanks located at Salt Lake Refining Company.

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maintain the old ratio of reserves to demand. This would add another 35 percent to the finding efforts necessary. In other words, producers will have to find over 1-1/3 barrels of new oil for every barrel actually produced in order to maintain reserves.

By 1967 all refinery equipment, and distribution equipment and plants will have to be built or stepped up in efficiency to handle twice the 1950 volume. We do not know just how much of the crude needed will be found in the United States, but we are inclined to feel that a larger proportion of our needs over the years must be found abroad and imported.

Another way of looking at this is that it took the industry from 1859 to 1950—91 years—to grow enough to handle 6.5 million barrels a day, and within the 17 years from 1950 to 1967 it will have to create new facilities equal to 100 percent of the size it had attained after the first 91 years of development. Rather than worry about the small rate of growth envisioned for 1958, we should really be worried as to how we can finance and create the facilities necessary to meet the demands for 1967.

Military Honors Socony

The Socony Mobil Oil Co. has received the Department of Defense Reserve Award for "outstanding cooperation" in policies toward military reservists and reserve activities.

The award, consisting of a pennant and a certificate of citation, was presented to B. Brewster Jennings, chairman. Jennings accepted the award on behalf of the company and its employes who have served in the Armed Forces and are continuing to serve through participation in the Nation's Reserve program.

Reserve officials complimented the Socony-Mobil for its outstanding record of cooperation with the Armed Forces and its liberal policies with respect to furtherance of the Reserve Program.

Chemicals, Oil, Well Mixed

Houston independent oilman Michel T. Halbouty told a Houston convention of chemical industry market research and development representatives that their industry and the modern petroleum industry are thoroughly intertwined.

Halbouty, a petroleum engineer, geologist, and international authority on salt dome structures, addressed the joint meeting of the Chemical Market Research Association and the Commercial Chemical Development Association, in the Shamrock Hilton Hotel.

There is plenty of oil left in America, Halbouty said, to meet the increasing demands for oil and gas generated by the growing petrochemical industry.

Only a fraction of their potential production has been surrendered to man by many of the old salt dome structures, he added. More will be found when oilmen learn more about these unusual formations.

The theme of Halbouty's talk was the interrelationship between the oil and chem-

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What's Happening. . .

ical industries, and their equal debt to the birth of the Gulf Coast oil industry at Spindletop.

Illustrating his theme, Halbouty briefly sketched the genesis of a synthetic rubber automobile tire from the rock-chipping of a West Texas geologist to the molding of the tire in an Akron rubber factory. He told of the many risks along the way, and the vast amounts of technology, manpower and money involved.

Gas, oil sulphur and salt water, all of the raw materials of the petrochemical industry, were present at Spindletop, Halbouty said. After Spindletop it remained only a matter of learning to use them better.

A decade ago, the word "petrochemical" was not even listed in dictionaries, Halbouty said. Today, 150 petrochemical companies spread across a 600 mile arc from Brownsville to Baton Rouge annually turn out more than 3000 separate petrochemical products ranging from lipstick and lace to vitamin pills and synthetic blood vessels. Fifty of these companies are oil companies, he pointed out.

Chemistry and petroleum are especially intertwined, he said, in efforts to reach that end by constant research toward newer and better products, meeting the challenge.

Home for 'Orphan Ideas'

A scientist with bright ideas is not necessarily good at selling them, every research director knows this. Standard Oil Co. (Indiana), however, plans to do something about it.

The ideas a scientist finds hardest to sell are those outside his own research field. Unless he knows his employer will give serious consideration to such brainchildren, he tends to stop offering them.

To provide a home for these ideas, Standard has set up an "orphan ideas" committee. More formally, it is entitled the Committee for the Evaluation of Research Suggestions.

"We want to make sure no good idea dies an untimely death," said Dr. P. C. White, manager of research. "In addition, we want to encourage broad thinking. Often the scientists working on a project become so close to it they miss its outside relationships." As a development that might have come earlier if outside relationships had been seen, Dr. White pointed to polyethylene.

As an indication of the importance attached to "orphan ideas," Standard has placed at the head of the new committee, Dr. Ernest W. Thiele, associate director of research. The three other members are all experienced research supervisors: Dr. C. E. Adams, R. J. Hengstebeck, and Dr. Philip Hill.

The committee will merely evaluate. Any promising idea will be given a home with the appropriate research division, for exploratory work.

API Refiners Elect Officers

At the open meeting of the Division of Refining during the 37th Annual Meeting of the American Petroleum Institute in Chicago last month, members heard the report of their nominating committee presented by H. W. Field, chairman. Thereupon the members elected the following to serve on the general committee of the Division of Refining for 1958:

L. G. Alexander, International Refineries, Inc., Wrenshall, Minn.; E. W. Allen, Wilshire Oil Co. of California, Los Angeles; W. R. Argyle, Commerce Oil Refining Corp., New York; S. G. Baker, E. I. duPont de Nemours and Co., Inc., Wilmington, Del.; B. H. Barnes, Gulf Oil Corp., Pittsburgh, Pa.; Harry A. Brown, D-X Sunray Oil Co., Tulsa; W. J. Carthaus, Great Northern Oil Co., St. Paul, Minn.; D. L. Campbell, The British American Oil Co., Ltd., Toronto, Ont., Canada; V. B. Chance, Atlas Processing Co., Shreveport, La.; and R. M. Chesney, Kerr-McGee Oil Industries, Inc., Oklahoma City.

Also, Robert G. Clark, Utah Oil Refining Co., Salt Lake City; R. T. Colquette, Crown Central Petroleum Corp., Houston; Miles F. Cowden, Cooperative Refinery Assn., Kansas City; G. Davidson, Shell Oil Co. of Canada, Ltd., Toronto, Ont., Canada; G. A. Davidson, Standard Oil Co. of California, San Francisco; David E. Day, Richfield Oil Corp., Los Angeles; G. S. Dunham, Socony Mobil Oil Co., Inc., New York; J. H. Dunn, Shamrock Oil and Gas Corp., Amarillo, Texas; Roy Diwoky, Commonwealth Oil and Refining Co., Ponce, Puerto Rico; and E. E. Ebner, Quaker State Oil Refining Corp., Emlenton, Pa.; A. G. Farquharson, McColl Frontenac Oil Co., Ltd., Montreal, Que., Canada.

Also elected were, A. P. Frame, Cities Service Co., New York; P. N. Gammelgard, The Pure Oil Co., Chicago; C. O. Garbrecht, Bay Petroleum Corp., Denver; W. T. Hancock, Hancock Oil Co., Long Beach, Calif.; A. V. Hoffman, South Penn Oil Co., Oil City, Pa.; Sam I. Hulse, Warren Petroleum Corp., Tulsa; H. Y. Hyde, Tidewater Oil Co., San Francisco; P. A. Kahle, Frontier Refining Co., Cheyenne; T. B. Kimball, Sinclair Refining Co., New York; L. E. Kincannon, Rock Island Refining Corp., Indianapolis; K. E. Kingman, Union Oil Co. of California, Los Angeles; D. M. Krausse, Cosden Petroleum Corp., Big Spring, Texas; J. L. Laird, Suntide Refining Co., Corpus Christi; R. E. Lauterbach, General Petroleum Corp. Los Angeles; Harry A. Logan, Jr., United Refining Co., Warren, Pa.; M. P. L. Love, Shell Oil Co., New York; R. E. Luton, The Ohio Oil Co., Findlay,

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- Duriron is applicable in all soils.
- Duriron has dense homogeneous structure and high weight factor for longer life per anode size.
- Duriron has good electrical conductivity.
- Duriron is mechanically strong. Metal-to-metal contact avoids loss due to poor connection.

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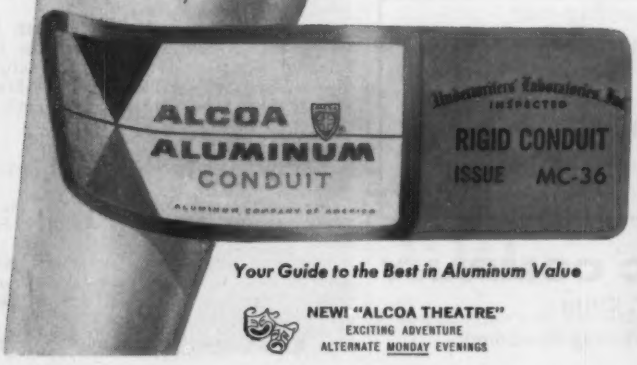

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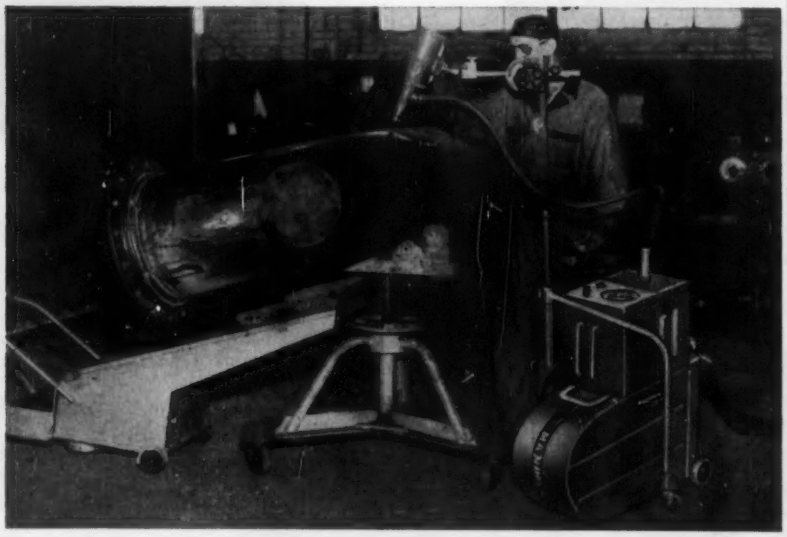
Ohio; and E. E. Lyder, U. S. Oil and Refining Co., Tacoma.

Also, E. B. McConnell, The Standard Oil Co. (Ohio), Cleveland; F. W. McCurry, Derby Refining Co., Wichita; S. A. Montgomery, Standard Oil Co. (Indiana), Chicago; F. C. Moriarty, Aurora Gasoline Co., Detroit; H. G. Osborn, Continental Oil Co., Houston; H. M. Paulsen, Bankline Oil Co., Los Angeles; W. S. Peeler, The American Oil Co., New York; John S. Pfarr, Leonard Refineries, Inc., Alma, Mich.; L. W. Robbie, Republic Oil Refining Co., Texas City; Sam Roberson, The El Dorado Refining Co., El Dorado, Kans.; J. B. Rogerson, Lion Oil Co., El Dorado, Ark.; R. G. Sanders, Magnolia Petroleum Co., Beaumont, Texas; A. W. Scott, Wolf's Head Oil Refining Co., Oil City, Pa.; J. L. Sewell, Delhi-Taylor Oil Corp., Dallas; and D. S. Simmons, Imperial Oil Ltd., Toronto, Ont., Canada.

Others included H. V. Smith, Kendall Refining Co., Bradford, Pa.; J. S. Stackner, Clark Oil and Refining Corp., Blue Island, Ill.; I. J. Staid, Carter Oil Co., Billings, Mont.; W. F. Stroud, The Atlantic Refining Co., Philadelphia; C. C. Tate, Phillips Petroleum Co., Bartlesville; C. H. Thayer, Sun Oil Co., Philadelphia; Clay Thompson, Mohawk Petroleum Corp., Bakersfield, Calif.; O. V. Tracy, Esso Standard Oil Co., New York; B. B. Turner, Ethyl Corp., New York; J. W. Vaiden, Skelly Oil Co., Tulsa; Russell H. Venn, Humble Oil and Refining Co., Houston; J. S. Wertz, The Vickers Petroleum Co., Inc., Wichita; Kenneth A. West, Canadian Oil Companies, Ltd., Corunna, Ont., Canada; John S. Worden, The Texas Co., New York; and R. E. Yancey, Ashland Oil and Refining Co., Ashland, Ky.

Simultaneously, President Frank M. Porter announced the appointment of five members of the board of directors to membership on the general committee. They are Guy B. Hunter, National Petroleum Assn., c/o Quaker State Oil Refining Corp., Emlenton, Pa.; Harry J. Kennedy, Western Petroleum Refiners Assn., Tulsa; Glenn E. Nielson, Husky Oil Co., Cody, Wyo.; Roland V. Rodman, Anderson-Prichard Oil Corp., Oklahoma City; and George T. Tennison, Natural Gasoline Assn. of America, c/o Shell Oil Co., Houston.



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OCAW Eying Short Week

O. A. Knight, president of the giant Oil, Chemical & Atomic Workers union said last month that the union's advisory board will meet in January to discuss what ought to be done about possible "sizable" future layoffs.

Knight's statements cited the impact of new equipment and automation on oil and chemical industries' labor forces, and said that it's about, "time to take a serious look at the matter of a shorter work week."

While Knight probably isn't ready yet to recommend negotiations for shorter work week, he contends that both union and employers should study the idea of standby clauses for "reduction" of hours as an alternative to layoffs, if and when layoffs are threatened in any given plant or operation.

The board meeting is to be held in Denver, but the specific date in January has not yet been set.

Amoco Starts Cartridge Production at New Plant

Producton of starter cartridges for jet aircraft engines has commenced at the new Amoco Chemicals Corp.'s plant at Seymour, Indiana.

Initially, the entire output of the million-dollar plant will go to the Air Force to fulfill a $3.5 million contract for cartridges signed last March. Ultimately, it is expected that the relatively low cost and the smokeless and control features of the chemicals used will make the propellant attractive for other uses.

The cartridges were developed by the research staffs of Standard Oil Co. (Indiana), Whiting and Seymour laboratories, and mark the company's entry into the field of solid propellants.

The plant was constructed by Blaw-Knox Co., Pittsburgh.

Electrical Group Formed

A new organization is being formed for the purpose of disseminating practical information about the properties and uses of electrical insulating materials. The name of the organization is Electrical Insulating Materials Association.

It is the purpose of this association to provide a means of establishing better communications in the electrical and electronics industries, specifically on the application of electrical insulating materials. The need for this has long been felt, and is reflected in the current programs of such organizations as the AIEE, NEMA, Electro Chemical Society, ASTM and others.

Inquiries should be directed to H. H. Chapman, Jr., Manager, Apparatus Insulation Textile Products Division, Owens-Corning Fiberglas Corp., 598 Madison Avenue, New York 22, New York.

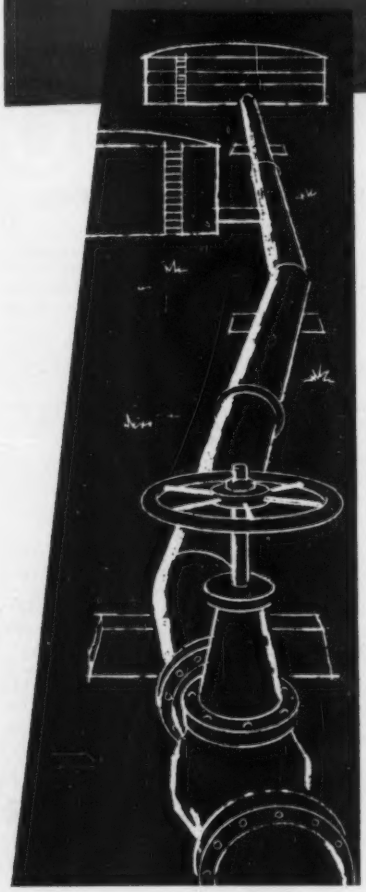
Independents Plan Action

The Independent Refiners Association of America held its annual meeting last month in Chicago. Problems faced by the independent refiner were discussed, and a program of action along a broad front, mostly centering in Washington, was adopted which included:

1. Urging voluntary curtailment of re-

Sinclair Refining reports...

Instantaneous, accurate gaging with S&J Datalogger!



Sinclair's new S&J Datalogger permits reliable tank gaging regardless of time or weather conditions. In addition, the S&J Datalogger provides permanent records for checking each day's operation at Sinclair's Hartford, Illinois refinery.

Proven S&J Dataloggers are ready now to help you get records of tank levels, temperatures and other physical data—faster and more accurately.

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finery runs by the entire refining industry to attain balanced inventories.

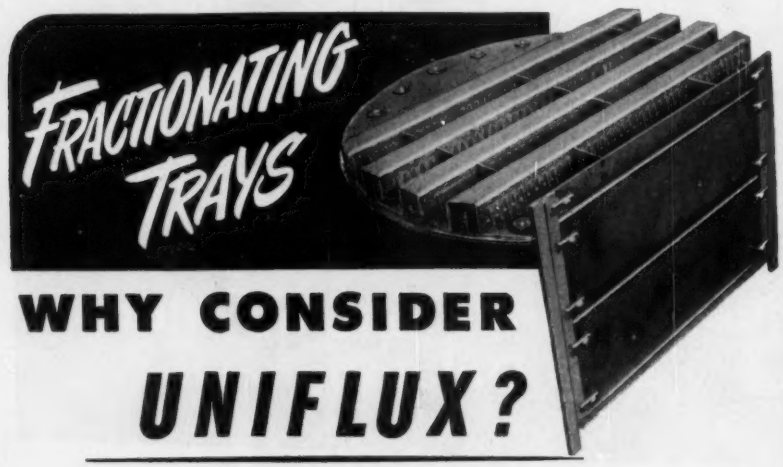
2. Calling for a cessation of the octane race to eliminate the high cost of octanes excessive to the consumers needs.

3. Renewing its demands to the government that the voluntary import control program be expanded to cover the importation of petroleum products, which are showing a marked increase.

H. Robineau, president of the Association, said that, "The Association will continue to battle for industry-wide objectives. It will support the Natural Gas Bill and it will oppose legislation adverse to the interests of the industry and the public, such as any attempts to undermine the depletion allowance now accorded producers."

The association reiterated its position against extension of the military exemption from the Buy American Act. Its objection to this special exemption for government purchases of oil had already been stated to the Department of Defense and the association has been advised by the department that revision of the exemption is under study there.

The association also called for improvement in military procurement functions in other respects. In particular, it felt that the small business set-aside procedure could be improved and made more equitable.



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StanCal Adds Grants

Standard Oil Co. of California has announced plans to award in 1958 more than $100,000 in unrestricted grants to 26 private colleges in the United States. The grants supplement the broad program of scholarships, fellowships, scientific grants and special services already included in its general program of aid to education.

The unrestricted grants will help defray general expenses at the 26 colleges and do not replace the company's established program of scholarships, fellowships and research grants for specific purposes.

The over-all program of Standard and its subsidiaries for aid to education through fellowships, scholarships, unrestricted aid, technical grants and special services will amount to more than $1 million in 1958. Included in this program are 11 fundamental research projects at eight universities, approximately 50 technical fellowships and approximately 250 undergraduate scholarships at some 100 colleges. In the case of nontechnical scholarships, choice of the field of study is left to the discretion of recipients.

Cities Service Buys Plant

Purchase by Cities Service Oil Co. of the Lehman, West Texas gasoline plant from Llano Grande Corp., Houston was announced recently by Robert L. Kidd of Bartlesville, Okla., president of Cities Service Oil Co.

The plant is located in Cochran County, four miles south of Lehman and 25 miles west of Levelland. Through an extensive gathering system, the plant serves the West Levelland field. It was designed and constructed by Tellepsen Construction Co., Houston, contractor, and was placed on stream early in 1955. The plant was designed to process 25 million cubic feet of gas daily.

Italy Making New Plastic

A radically new thermoplastic is now in commercial production in the Ferrara, Italy, plant of Montecatini Societa Generale. The new plastic is made from low-cost propylene gas by a low-pressure catalytic process.

Montecatini started intensive research on polymerization of alpha-olefins, under the guidance of Professor Guilio Natta at Milan Polytechnic. Professor Natta succeeded in developing a new method of synthesizing olefins, a method which produces an unusual regularity of structure and a controlled crystallinity in the plastic. This gives it high resistance to heat (over 300 F.) which permits sterilization of molded products and which will open many new fields for the plastic. It is said to have excellent resistance to grease and oil, water, high electrical properties, resistance to many common acids, high impact strength, and in many applications outperforms conventional plastics materials.

According to company spokesmen, it will begin to appear on the American market next year in the form of sterilizable opaque to translucent household products, squeeze bottles, baby bottles, pipe and fittings, and in textile machinery parts, electrical and mechanical components such as tape-recorder housings, pump parts, automotive parts and the like. The surface finish of the plastic, and its colorability, are other advantages.

This is the first commercial product to

For more data on advertised products, use Readers' Service Cards, last page.

TRUFIN TYPE L/C IS IDEAL TUBE FOR AIR COOLERS

Wolverine Trufin Type L/C is a specialized tube developed by Wolverine Tube after years of research. It is particularly effective in such applications as air cooled gas coolers, air cooled water coolers, air cooled hydrocarbon condensers and air cooled steam condensers—to name but a few.

Trufin L/C's construction features an outer tube of high-finned aluminum tube mechanically bonded to an inner liner of such metals as copper, Admiralty, 85-15 red brass, low carbon welded steel, 90-10 and 70-30 cupro nickel—among others.

Wolverine Trufin Type L/C is available in standard sizes and fin spacings. Its fins—like those of all Trufin types—are an integral part of the tube and are unaffected by vibration, thermal shock or temperature variations. Liners can be made to standard condenser tube specifications and tube ends can be furnished with full finned ends or fins stripped to liner size. Stripped ends are provided to permit easy installation into headers for rolling-in or brazing operations.

TUBING PROBLEMS SOLVED BY F. E. S.

For the convenience of its customers, Wolverine Tube maintains a Field Engineering Service staffed with highly trained tubing technicians.

In addition to their own specialized training these men are backed by the experience and knowledge gained by Wolverine during its years of tubing leadership.

Members of the Field Engineering Service are available at all times to help solve problems in design, corrosion, tubing selection—or what have you. Next time you have a problem ask for a Wolverine Field Service Engineer—there is no obligation.

SEND FOR FREE BOOK

Valuable information concerning the various types of Wolverine Trufin available—their construction features, alloys and size ranges as well as the applications where each can be used to full advantage is contained in the Trufin Catalog. Write—TODAY for FREE copy.

Use Spreads:

Heat Transfer Revolution caused by Wolverine Trufin®

BY ERNEST DODD

Nowadays being called a revolutionary is almost fighting talk. Except—that is—when the term is used to describe Wolverine Trufin—the integrally finned condenser tube. Trufin is responsible for the technical revolution now underway in the field of heat transfer operations.

From coast to coast and from the Canadian border to the Rio Grande, more and more refineries and processing plants—as well as original equipment manufacturers—are specifying Wolverine Trufin, in its various forms, for use in both new and existing heat exchangers and condensers.

An excellent example of this is to be found in the air-cooled heat exchangers manufactured for major refineries by one of the nation's leading fabricating companies. This company's air-cooled units are designed around Wolverine Trufin Type L/C—a two-purpose tubing composed of an outer tube of high-finned lightweight aluminum mechanically bonded to a liner tube of any desired metal.

By using Trufin Type L/C, the fabricating engineers kill two birds with one stone . . . step up BTU transfer . . . and combat corrosion by specifying an inner liner of any needed metal or alloy.

Still another well-known fabricating company recently completed an order in which the units were also designed around Wolverine Trufin. This time, however, the tubing used was Wolverine Trufin Type S/T (for shell and tube use) and the exchangers were fuel oil heaters designed to speed up oil flow at a large tank farm. In this case, with steam in the tubes and fuel oil in the shell, the oil is in at 100°F and out at 125°F—for a completely successful operation.

And so from here, there, and everywhere around the country—come stories of how Wolverine Trufin—and its integral fins helps engineers improve heat transfer performance. If your company hasn't as yet tried this outstanding tube why not use it next time you retube existing equipment or design new units.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
17236 SOUTHFIELD ROAD • ALLEN PARK, MICHIGAN

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

Wolverine Trufin is available in Canada through the Unifin Tube Co., London, Ontario.

TUBULAR TIME SAVER

Saving time is important—it is directly reflected in both output and financial earnings.

You can save time—lots of it—by using prefabricated Wolverine U-Bend condenser tubes in either finned (Wolverine Trufin) or prime surface form.

Wolverine bends condenser tubes to your specifications—ships them in disposable box-type pallets in the exact order of their installation—ready for direct insertion into your heat exchanger or condenser.

In addition to assembly time, you eliminate the transportation, space and handling headaches present when dealing with tubes over 30 feet long. One tube sheet is eliminated and floating head problems are reduced. Rolling in operations are cut in half.

Wolverine prime surface tube U-Bends are available in a wide range of sizes and alloys in copper, copper-base alloys and aluminum. Capacity boosting Trufin U-Bends are available in copper, copper-base alloys, aluminum and electric-welded steel. Complete information is contained in Wolverine's Condenser Tube Catalog. Write today.

BUY WOLVERINE TUBE—IT'S MADE IN AMERICA

CALUMET & HECLA, INC.
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WOLVERINE TUBE

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PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.

come from Montecatini's work with stereospecific catalysts begun with the polypropylene synthesis.

Professor Guilio Natta of Milan Polytechnic first discovered that certain catalytic agents under specific conditions acted on olefins to produce an exceptional regularity of structure (which he named "isotactic") and would permit, by process adjustment, control of the degree of crystallinity of the synthesized polymer. As a result, a polypropylene plastic can be produced with a high degree of crystallinity. Up to now, most synthetic plastics have been predominantly amorphous in structure, with some crystallinity, but the amount of crystallinity was not subject to control during processing.

No New Imports for Resale

Import Administrator Carlson said last month that new importers must use oil imports "for their own purposes and cannot import for resale."

With all but three companies now complying with the voluntary import program, the October imports were 4400 bpd below revised import allocations of 771,400 bpd recommended by a Cabinet committee for the year ending June 30, 1958.

The previous total of 766,400 barrels daily was revised to include the new allotment of 5000 bpd to Crown Central, the first new importer to get its quota under the voluntary program.

There are six other companies which have applied for quotas, but Carlson contends that they will have to demonstrate compelling reasons for initiating imports. He added that companies contemplating oil imports under the program must use the import for their own purposes, and cannot import for resale. Along these same lines, Carlson also pointed out that just because a company says that it will use imports, is in itself, no guarantee that an allotment will be granted.

Asphalt Sales Dip Slightly

The Asphalt Institute has reported that after six years of record production, there may be a slight dip in aspalt sales. This year's decline may be attributed partly to setbacks in highway paving schedules and a decline in home building.

The Institute does, however, expect an upturn in asphalt business for 1958 and 1959 when numerous projects in the federal road-building program reach a paving stage.

Octanes Continue to Climb

Gasoline on sale at service stations in November rose to national weighted averages of 98.4 octane number for premium and 91.0 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

The premium gasoline average was 0.3 octane number above the October level and 1.1 octane number above a year ago. The regular gasoline average was up 0.1 octane number over October and 0.7 octane number higher than a year ago.

Forty-two of the 57 cities in Ethyl's survey reported increases over October in the average octane number of their premium gasoline, eleven by 0.5 octane number or more. Eight cities reported decreases and seven cities were unchanged. In regular gasoline, 30 cities reported increases over October in their average antiknock quality, two by 0.5 octane number or more. Twenty cities reported decreases while seven cities were unchanged.

Compared with the nationwide premium average of 98.4 octane number, ten cities reported premium averages of 99 octane number or higher. In regular gasoline, 18 cities showed average octane ratings of 91.5 octane number or higher compared with the national weighted average of 91.0 octane number.

For companies marketing more than one grade of premium, the survey showed a range of 100.1 to 101.9 octane for the highest grade, on the basis of 37 samples in 19 cities.

What's Happening . . .

Radiation Source to Esso

Esso Research and Engineering Co. has received the most powerful radiation source ever shipped by the Atomic Energy Commission's Oak Ridge, Tenn., facility for private industry use.

The radioactive material is being used by the company in its Linden, N. J., laboratories where scientists are pushing toward practical application of atomic energy in the oil industry.

The shipment contained about 15,000

In Refractory Castables for the Refining Industry

WALSH has them ALL!

- Greater strength—better bond—throughout the complete temperature range.
- Maximum resistance to abrasion.
- "Iron-Free" (less than 1% iron content in Super Castable No. 32 & No. 50 NISF —to meet the needs of the petroleum refining industry.)

PRODUCT	MAXIMUM OPERATING TEMP.	WEIGHT DRY IN PLACE PER CU. FT.	FIRED CRUSHING STRENGTH (PSI)	
H & B Castable No. 8	2700° F.	128-130 lbs.	1100° F.—2000 1500° F.—1600 2000° F.—1900	WALSH H & B CASTABLES—Regular and Extra Strength—mix readily with water for casting, trowelling or air gunning. Form monolithic lining highly resistant to abrasion. Used for working linings in catalytic regenerators, reactors and other refinery equipment.
Extra Strength H & B Castable	2450° F.	128-130 lbs.	1100° F.—2200 1500° F.—1800 2000° F.—2100	
Castable No. 150	3400° F.	170-172 lbs.	1500° F.—7500 2550° F.—7600 3000° F.—8000	An hydraulic, "iron free" castable, producing highest resistance to abrasion at all temperatures.
Super Castable No. 32	3000° F.	130-134 lbs.	1500° F.—2900 2550° F.—3600 3000° F.—5000	Super Castable No. 32, an "iron free" castable, with excellent strengths at critical operating temperatures. Adheres readily where used as a patching material.
Lite Wate Castable No. 50	2100° F.	62-64 lbs.	600° F.—385 1500° F.—310 2000° F.—400	WALSH LITE WATE NO. 50 and 70, Insulating Castables. Can be readily trowelled and poured. Absolute minimum rebound loss when applied with air gun. Good strength with low heat conductivity—more than five times as resistant to heat flow than fire brick. Produce desired linings for flues and ducts, back-up linings for catalytic reactors and regenerators, and other refinery equipment.
Lite Wate Castable No. 70	2300° F.	80-82 lbs.	600° F.—500 1500° F.—450 2000° F.—1300	
Lite Wate Castable No. 50 NISF	2000° F.	51-53 lbs.	1000° F.—480 1500° F.—450	

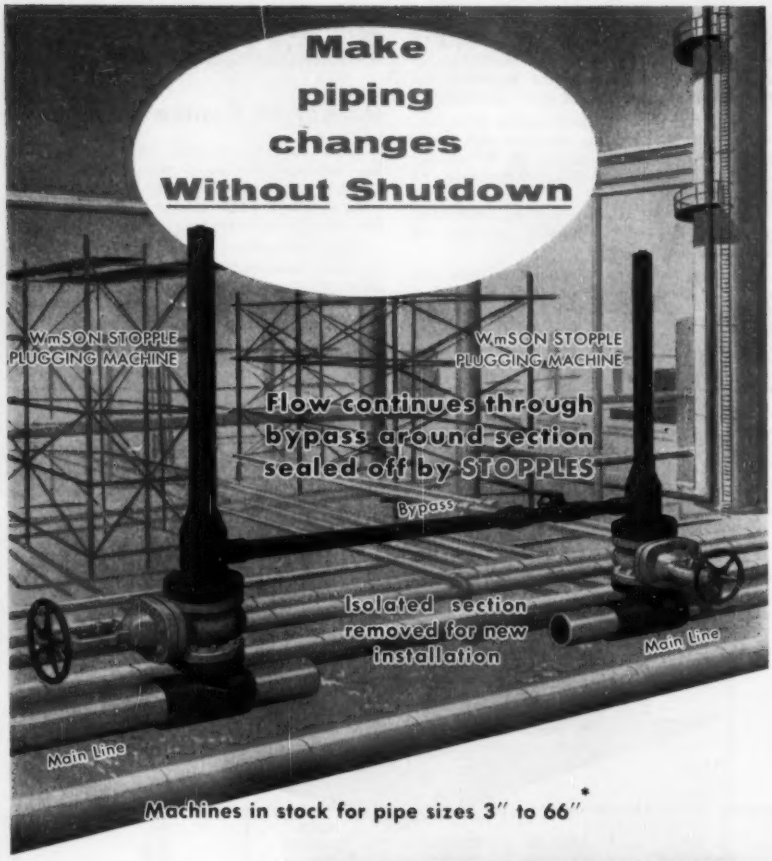
Send for NEW CASTABLES BULLETIN

WALSH REFRACTORIES CORP.

101 Ferry Street • St. Louis 7, Missouri

For over 60 years manufacturers of high grade refractories

For more data on advertised products, use Readers' Service Cards, last page.



Large inland Refinery tests 8" Stopple in steam line at 475° F. Held 160 PSI pressure 5 days without leakage.

Machines are for steel or cast iron pipe containing:
• Oil • Gas • Steam
• Gasoline • Water • Propane

Write for article reprints telling how Plants and Pipeline Companies use WmSon STOPPLES and TAPPING MACHINES.

*STOPPLES and TAPPING MACHINES may be rented or purchased

T. D. Williamson, Inc.
P. O. BOX 4038 TULSA 9, OKLAHOMA
REPRESENTATIVES: HOUSTON • AMARILLO • PITTSBURGH • JOLIET, ILL. JACKSON, MICH. • LOS ANGELES • SAN FRANCISCO • BARTLESVILLE, OKLAHOMA • SEATTLE • SALT LAKE CITY • EDMONTON • TORONTO WINNIPEG • VANCOUVER • BUENOS AIRES • CABIMAS, ZULIA, VENEZUELA • DURBAN, NATAL, S. AFRICA • PARIS, FRANCE • SIDNEY, AUST.

What's Happening . . .

curies of radioactive cobalt. This is equivalent in activity to about 33 pounds of pure radium and represents more than seven times the world supply of refined radium.

The radioactive material is in the form of about 300 nickel-plated pieces resembling small thick coins weighing a total of less than one pound. The concentration of radioactivity is so high, however, that the Esso scientists will be able to produce and study radiation intensities approaching those obtainable from nuclear reactors.

The sources emit gamma rays and the research is aimed at determining the role these rays can play in promoting the chemical reactions which made modern oil refining possible.

It has been discovered that thermal cracking reactions can be accomplished with radiation at temperatures 50 to 100 degrees lower than those necessary when using conventional methods alone—indicating that the essential chemical reactions can be started up with relatively small quantities of radiation.

Sohio Falls into Import Line

The Standard Oil Co (Ohio) is the latest importer to fall into line with government's voluntary crude imports program. Previously, Sohio had only agreed to import limitations to the first of the year. Now, the company has agreed to extend this time to June, 1958.

Out of the 25 importers, only three have not fully committed themselves to the import program. These are Eastern States Petroleum and Chemical Co., Tidewater Oil Co., and Sun Oil Co.

World Refining Mark Set

A recent British study by the Petroleum Information Bureau shows that the world refining capacity may have reached the 20 million bpd mark. The study puts the capacity at 18.8 million bpd at the end of last year, then projects that at least 2 million bpd has been added.

Other highlights of the report stated that:

Capacity rose 2.32 million bpd during 1956.

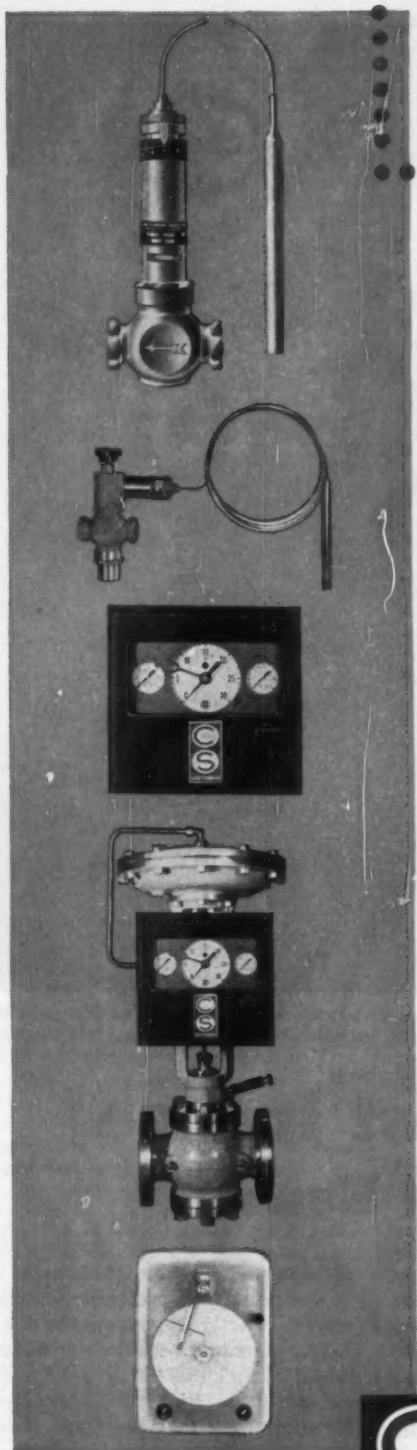
U. S. companies owned 59 percent of the world total at the beginning of this year with 2.8 million bpd of it being in overseas plants.

British and associated Dutch companies with a capacity of 2.8 million bpd own 15 percent of the total.

The Soviet bloc with 1.8 million bpd had ten percent.

U. S. is running about nine million bpd, Western Europe 2.74 million bpd, and Latin America 2.34 million barrels, daily.

NOW!
Turn to Page 327
and read
"Changing Times"



For Accurate, Reliable Temperature Control

STACON V SERIES
Self Operating Temperature Regulators—

Feature a liquid filled thermal system for high operating power and uniform throttling action and has built-in over-load protection. Available in 50°F. and 100°F. ranges from 25° to 325°F. Direct and reverse acting units ¼" to 1½" with screwed ends, and 2" to 4" with flanged ends. Bulletin No. 500. (Cash Standard Stacon Corp.)

STACON TYPE VS
Temperature Safety Regulators—

Used in the supply steam or gas line and will protect a process by snapping shut when the process temperature goes above a desired temperature level. Easily adjustable and remains closed until manually reset. Available in sizes from ½" to 1½" with screwed ends. (Cash Standard Stacon Corp.)

CASH STANDARD TYPE 51
Indicating Controllers—

An air operated, mercury actuated proportional temperature controller. Temperature ranges from —40°F. to 1000°F. Calibrated set point adjustment, unit construction, air relay with sapphire orifice and push button cleaner, feedback type proportional control with 1-100% band and differential gap. Also available with 1-150% proportional band combined with automatic reset action. Bulletin No. 978. (A. W. Cash Co.)

CASH STANDARD TYPE 30
Diaphragm Control Valve (With Type 51 Mounted)

A rugged, dependable control valve—available in sizes ½" to 12" with various styles of inner valves—reverse or direct acting. Accurate control is assured when the Type 30 is used with 51 or 57 controllers, valve mounted as illustrated, or where the controller is installed remotely. Bulletin No. 980. (A. W. Cash Co.)

CASH STANDARD TYPE 57
Recording Controllers—

An air operated temperature controller with mercury, vapor, gas or organic liquid actuation. Temperature ranges from —350°F. to 1200°F. Available in 9" and 12" case size, spring or electric driven chart drive, on-off control or 1-100% proportional control.

All units have push button nozzle cleaner; proportional controllers also have sapphire jewelled relay orifice with push button cleaner. Bulletin No. 979. (A. W. Cash Co.), or write to Dept. L.

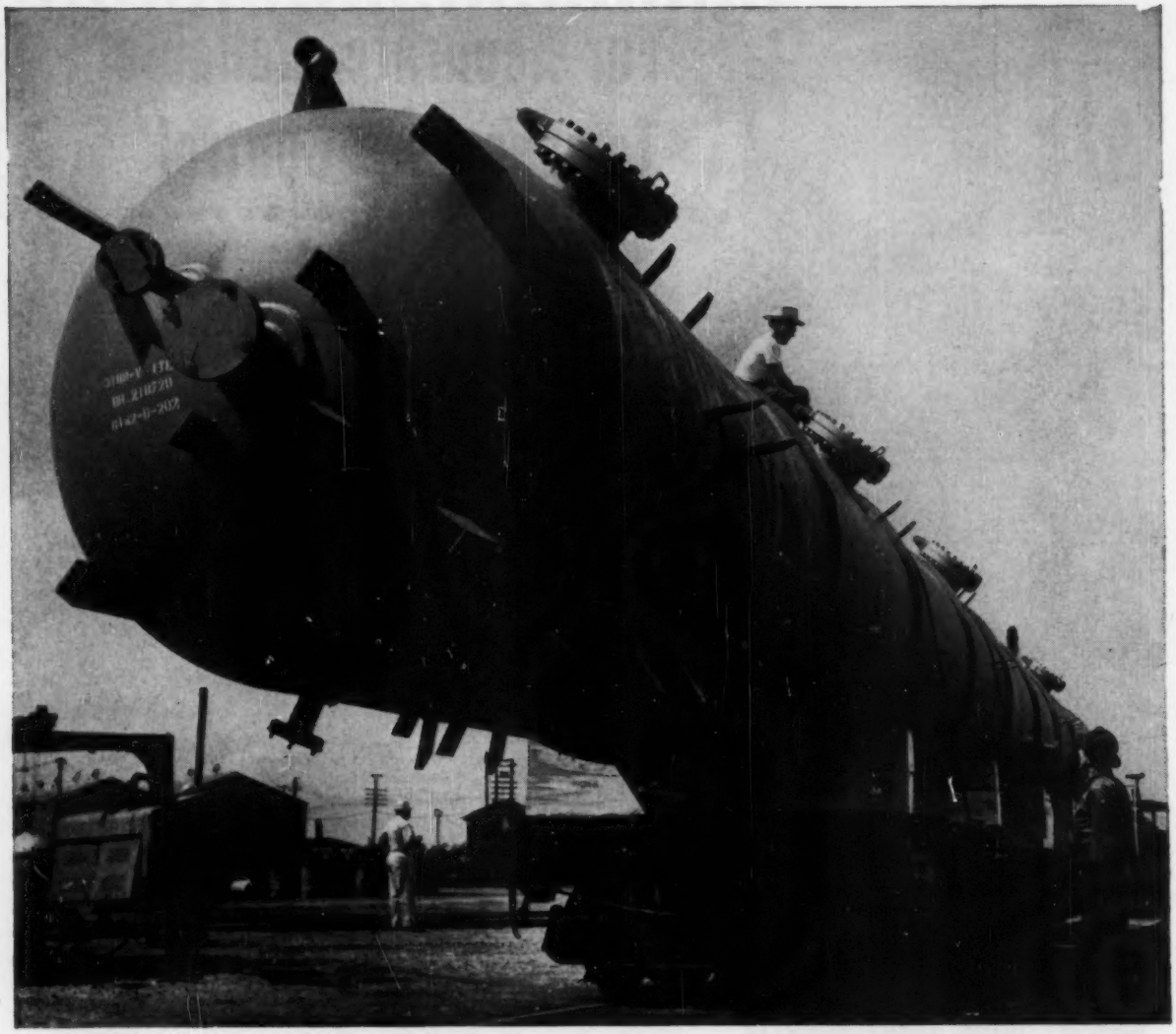
WHAT'S *YOUR* TEMPERATURE CONTROL PROBLEM?

CASH CS STANDARD

A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

For more data on advertised products, use Readers' Service Cards, last page.



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...*built by* Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

Engineers—Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

– Changing Times –

Recruiting of European scientists and engineers by American organizations is causing increasing annoyance in Europe. British Advisory Council on Scientific Policy reported that from 1950 to 1956, **six percent of postgraduate chemists leaving universities emigrated to U.S. or Canada,** and number may be larger in 1957. Britain frowns on this, especially since many of them were educated at taxpayers' expense.

Fluor has established a **wholly-owned subsidiary in London,** England to take advantage of the rapid expansion of the petroleum and petrochemical industries in the Sterling areas and Free Europe.

Cities Service Oil Co. has purchased the Chico, North Texas, gasoline plant of the Atlanta Gas Co. Plant, located almost 60 miles northwest of Ft. Worth, in Wise County, is presently processing 12 million cubic feet of gas daily. Output is 33,000 gallons of liquids daily.

Gulf Oil has stopped shipping crude oil into its 18,500 bpd topping plant at Staten Island, N.Y. Installation is still in use however, as storage terminal and bulk plant. Blending and packaging is also being done there.

Employes at Shell Chemical's Torrance, Calif., plant in bargaining representation election **voted 475 for no union,** 213 for OCAW, and 12 for International Union of Operating Engineers.

Shell Oil has developed a **new radiation-resistant grease** which is now commercially available. Grease is ideal **for nuclear power plant use.**

Ceramic scientists at Armour Research Foundation have **developed a catalytic ceramic coating for piston heads** which shows promise of significantly reducing the amount of carbon monoxide and unburned hydrocarbons in exhaust gas.

Overseas Americans Inc., is a newly formed organization of construction and engineering workers employed and **interested only in overseas projects.**

New group will act as a clearing house for collecting, analyzing, and exchanging information concerning foreign construction and engineering projects under construction or proposed. Headquarters is 7 West 44th St., New York 36.

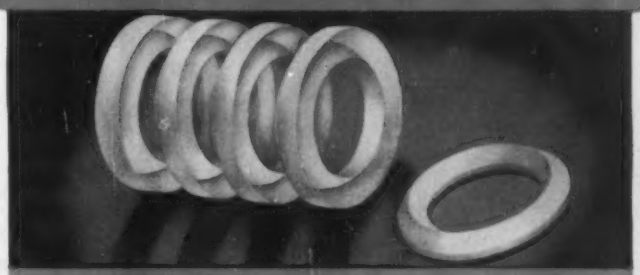
Total U.S. **roadbuilding in next 15-16 years will require some 13 billion gallons of petroleum products** Federal Highway Administrator reported to API.

A new type of lubricant which possesses qualities of true plastic and achieves long-term lubrication has been developed for use in business machines by Gulf Oil. While being worked the new product becomes thin and oily; when working stops, it returns to the consistency of a light grease. **Result:** it does not run off, or wear off the parts it protects.

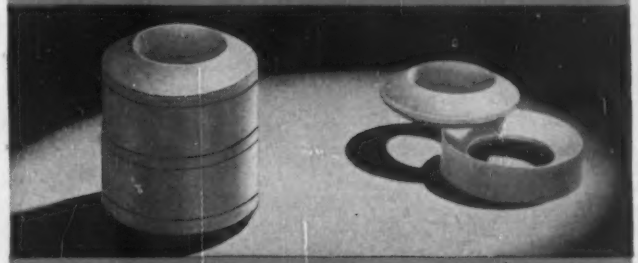
Chemiseal® Packings

MADE OF DU PONT TEFLON

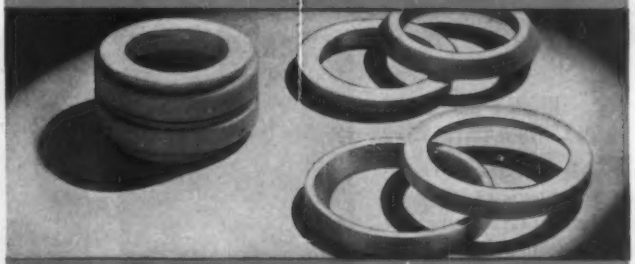
Last Months instead of Hours in Corrosive Service



V-Rings. Distinctive tapered V design offers greater flexibility and resiliency, providing necessary seal at low gland pressure and reducing torque on valve stem. Antihesive properties guard against valve packing "freeze". Supplied in sets with or without TEFLON* square-end adaptors.



Cup and Cone Rings. Cones deform inwardly to seal at the spindle, while cups expand outwardly against stuffing box wall, effecting a tight seal at low gland pressure with minimum friction on valve stem. Antihesive properties make this packing ideal for emergency shut-off service.



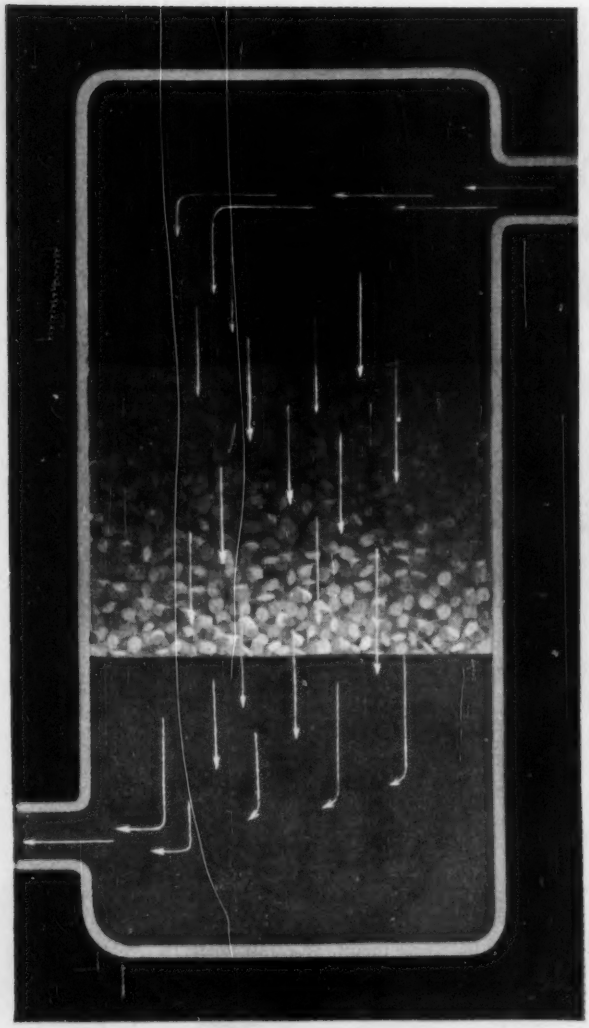
Wedge Rings seal at unusually low gland pressure required for valves manufactured from Haveg, Karbate, ceramics, etc. Provide space for thermal expansion, suiting them for slow-speed pumps, agitators, auto-claves, etc. Adaptable to spring-loading if desired. Write for Catalog AD-155.

*du Pont Trademark

United States Gasket Company
Camden 1, New Jersey

United States Gasket Plastics Division
OF THE GARLOCK PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.



New AERO* HDS-2
Catalyst
Unequaled in Efficient, Economical Feedstock Upgrading

New Cyanamid AERO HDS-2 extruded catalyst squarely meets modern hydrogen desulfurization requirements, featuring highest activity with low bulk density. Extensive laboratory and field performance data shows greater sulfur and nitrogen removal efficiency than other cobalt-molybdena types. Add the fact that the low bulk density of AERO HDS-2 gives up to 40% greater naphtha-treating capacity per pound of catalyst and you can see why it's the best buy for *your* hydrodesulfurization process.

Considerable performance data with reformer feed naphthas is already available on this outstanding product from another brand-new Cyanamid catalyst plant. This information will be glady supplied by your Cyanamid man. Write or phone him today.

*Trademark

HIGHLY SELECTIVE PLATINUM CATALYSTS

For normal or HDS-upgraded feedstocks, AEROFORM® Platinum Reforming Catalysts provide excellent performance in octane improvement. Good stability and easy regeneration contribute to their low cost-per-barrel.

TOP ANTI-WEAR FOR TOP LUBES

Where *extra* protection is required for engine break-in, AEROLUBE® 93-C concentrated zinc dithiophosphate does the job. Excellent oxidation inhibition and anti-wear properties make it ideal for both initial fill and regular use in premium oils.

The invaluable experience and advice of operating oil men is sought by Cyanamid's field men — is fed into our thoroughly modern laboratories — and results in superior, highly effective Cyanamid products. That is why each is so well suited for its recommended application.

CYANAMID

AMERICAN CYANAMID COMPANY, REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y. • In Canada: North American Cyanamid Limited, Toronto and Montreal

Esso Slates Powerformer

Esso Standard Oil Co. will build a 27,000-barrel-a-day Powerformer—one of the largest catalytic-reforming units in the oil industry—as a major part of a $46 million program of new construction and improvements at its Baton Rouge refinery.

The program also covers the cost of increasing aviation-gasoline output; expansion of facilities for production, storage and shipment of petrochemicals; expansion of lube oil production units; improvements to grease-manufacturing equipment; enlargement of the refinery's Central Mechanical Building and several other projects.

Badger Gets MEK Contract

Badger Manufacturing Co., Cambridge, Mass., has received its second contract this year for an MEK (Methyl Ethyl Ketone) dewaxing-deoiling unit. The first contract, earlier in the year, was awarded by the Atlantic Refining Co. The more recent job, including vacuum distillation facilities, was ordered for Sinclair Refining Co.'s East Chicago, Ind., refinery.

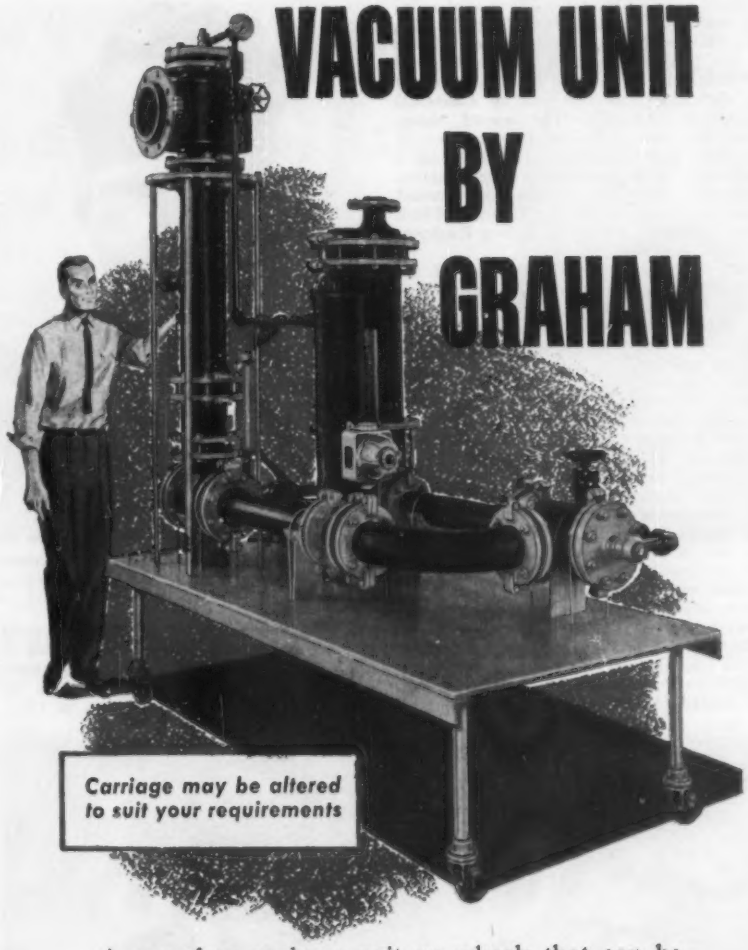
The Sinclair plant is expected to be on stream late in 1958 while the Atlantic unit will not be complete before early 1959. When operating, both units will produce high-grade products.

MEETINGS CALENDAR

1958	
JAN.	
14–15	Yankee Instrument Fair and Symposium, Boston, Connecticut Valley, and Fairfield County Sections, Inc., Hotel Bradford, Boston.
20–21	Compressed Gas Association, Inc., 45th Annual Meeting, Waldorf-Astoria, New York.
20–24	National Fire Protection Association, Committee Week, Manhattan Hotel, New York City.
FEB.	
2– 7	ASTM Committee D-2 Meeting, Rice Hotel, Houston.
2– 8	ASTM Committee D-2, Petroleum Products and Lubricants Meeting, Rice Hotel, Houston.
3– 4	Instrument Society of America National Conference on Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Delaware.
10–14	American Society for Testing Materials, Committee Week, Hotel Statler, St. Louis, Mo.
12–14	API Division of Marketing, Marketing Research Committee, Biltmore Hotel, New York City.
27–28	API Division of Marketing, Lubrication Committee Meeting, Sheraton-Cadillac Hotel, Detroit.
MAR.	
3– 4	Society of Petroleum Engineers of AIME, 4th Annual Joint Meeting, Cosmopolitan Hotel, Denver.
5– 7	API Oil Information Committee, St. Francis Hotel, San Francisco.
17–21	Fourth Nuclear Engineering and Science Conference, Chicago International Amphitheatre.
17–21	National Association of Corrosion Engineers, National Meeting, Civic Auditoriou, San Francisco.
APRIL	
13–18	American Chemical Society, 133rd National Meeting, San Francisco, Site Unreported.
15–17	Southwestern Gas Measurement Short Course, University of Oklahoma.
20–23	American Institute of Chemical Engineers, Montreal, Canada.

You CAN take it with you!

A *Portable* VACUUM UNIT BY GRAHAM



A complete package unit on wheels that can be moved from one job to another.

These Graham PORTOVAC assemblies are economical and efficient—zero maintenance—and low in initial cost.

Wherever you have steam we can give you vacuum.

Write for details in Bulletin 70-A

GRAHAM MANUFACTURING CO., INC.
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What's Happening . . .

. . . *Among Men* in the Industry

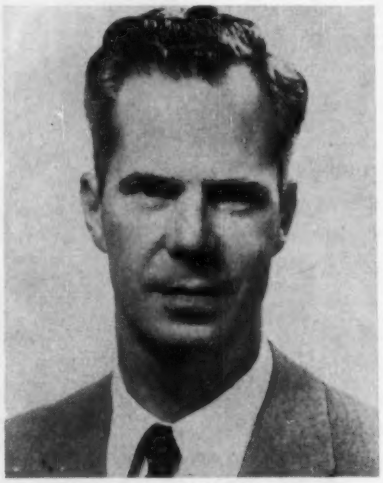
AIChE Names Dr. Haensel Winner of 1957 Progress Award in Chemical Engineering

Dr. Vladimir Haensel, director of refining research, Universal Oil Products Co., Des Plaines, Ill., has been named winner of the 1957 Professional Progress Award in Chemical Engineering, it was announced by the American Institute of Chemical Engineers (AIChE). The award, sponsored by the Celanese Corporation of America, and consisting of $1000 and a certificate, was presented to Dr. Haensel December 10 during the four-day annual meeting of AIChE at the Conrad Hilton Hotel, Chicago by Dr. J. Henry Rushton, Institute president.

Dr. Haensel is the 10th winner of the award which is presented annually to a chemical engineer who has not yet reached his 45th birthday, and has "made a significant contribution to the science of chemical engineering."

Dr. Haensel, a native of Germany, joined Universal Oil Products Co. in 1937 as a chemical engineer and two years later was assigned to the Ipatieff High Pressure Laboratory at Northwestern University as an assistant to Professor V. N. Ipatieff. In 1945 he inspected the German synthetic oil plants as a member of the Technical Oil Mission for the Petroleum Administration for War. From 1945 until 1955 he was coordinator for the Cracking Research division of Universal Oil Products Co., and in 1955 was named director of refining research.

Dr. Haensel received the 1944 Chicago Junior Chamber of Commerce Award and in 1952 he received the Precision Scientific Co. Award for achievement in petroleum chemistry. He was awarded an honorary doctor of science degree by Northwestern University in 1957.



Dr. Vladimir Haensel

Dr. Haensel received his B.S. degree in general engineering from Northwestern in 1935, his M.S. degree from Massachusetts Institute of Technology in 1937, and his Ph.D. degree from Northwestern in 1941.

L. A. Astley-Bell (right), president of Asiatic Petroleum Corp., was honored recently by Dr. Jose A. Mora, secretary general of the Organization of American States, for his efforts to enhance inter-American relations through education.

Fred W. Scheineman was named director of engineering; **Thomas A. Abbott,** engineering administration manager; **Dr. Robert B. Jacobs,** engineering research manager, and **George M. Keranen,** general engineering department manager for Standard Oil Co. (Indiana).

Scheineman has been manager of the general engineering department since the department was established in 1954. He has been with Standard since 1926 when he joined the company as an engineer.

The past five years Abbott has been manager of the engineering research department, the first to hold that post. He joined Standard in 1946 as executive director of the department.

Dr. Jacobs has been technical director of the engineering research department since 1952. He joined the company in 1947 as associate director of the department.

Since 1954 Keranen has been assistant manager of the general engineering department. He became associated with the company in 1927 as a design engineer at the Whiting, Ind., refinery.

D. L. Campbell and **E. D. Loughney,** both former vice-presidents, have been appointed to the newly-created positions of senior vice-presidents of The British American Oil Co., Ltd. These positions are a further step in the company's policy of decentralization.

Campbell

Campbell joined B-A after graduation as an engineer from the University of Saskatchewan and successively filled several important posts in the manufacturing department at refineries and head office. In 1948 he became manager of manufacturing and in 1954 was appointed vice-president. Campbell was elected a director of B-A in 1956. He is also a director of Trans-Northern Pipe Line Co., and B. A.-Shawinigan, Ltd.

Loughney was appointed a vice-president and elected a director of B-A following the acquisition of Canadian Gulf Oil by British American in 1956.

George W. Watts, director of engineering and engineering research for the Standard Oil Co. (Indiana) manufacturing department, has retired.

Watts was first employed by the company as a draftsman at the Whiting, Ind., refinery in 1915 after his graduation from the University of Illinois as a mechanical engineer.

He later became chief draftsman and chief engineer at Whiting, and in 1928 was appointed chief engineer for the manufacturing department of Standard. Watts was on leave of absence between 1943 and 1945 to the Oak Ridge, Tenn., nuclear energy plant.

When Watts returned to Standard in 1945 he was named director of engineer-

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THESE men, and dozens more like them at McKee, are experts in the art of spending *your* money *fast.* And that's to your advantage when you do business with McKee.

One of the not inconsiderable costs of engineering and construction of your new petroleum refinery, petro-chemical or chemical plant lies in the paper work and man-hours it takes to specify, select, purchase, expedite and inspect the material and equipment for the project.

McKee purchasing experts know how to get the *right* material, from the *right* source, at the *right* price, on the job at the *right* time. They know what they want and where to get it, anywhere in the world—how to use nearest sources to cut shipping costs—how to time deliveries for a minimum of handling expense at the site.

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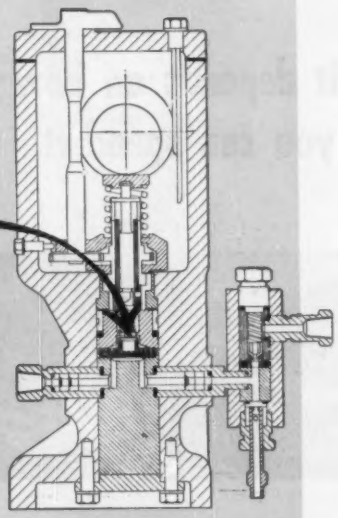
pump . . . meter . . . proportion exact fluid quantities over extended periods of time!

New McCannameter Diaphragm Pump* delivers exact amounts of fluids for any length of time. Pumps at pressures up to 2500 psi without staging. Operates at speeds up to 900 strokes per minute and flows up to 6 GPH.



new!

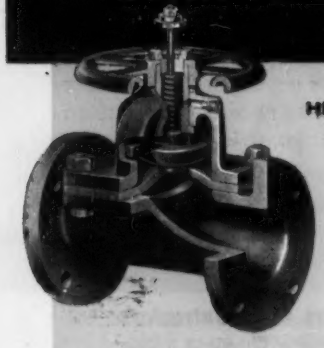
New Teflon-faced diaphragm permanently bonded to elastomeric backing provides chemical resistance, exceptionally long life. Packless design, positive displacement capsulated construction, lifelong lubrication, no fluid contact with frictional moving parts—these and many other features add up to new performance highs, new low cost!

*Write today for bulletin #301 describing and illustrating this completely new McCannameter Diaphragm Pump.**

*Pat. Appl. for.

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW



LEAK TIGHT FLOW CONTROL!
HILLS-McCANNA DIAPHRAGM VALVES

Positive flow control for all air, water, liquids, slurries, gases and corrosive services! Exclusive sealing bead diaphragm . . . simplified low-cost, in-line maintenance.

Write for 12-page catalog #104.

HILLS-McCANNA COMPANY,
2441 W. Nelson St., Chicago 18, Illinois

Men in the Industry . . .

ing. He established the engineering research department, and was director for both the engineering research department and the general engineering department.

William H. Clingman, Jr., has been promoted to group leader, petroleum section in the Research and Development department of American Oil Co., Texas City, according to **Dr. A. A. O'Kelly,** department director.

Clingman received a B.S. degree in chemistry from the University of Michigan in 1951 and a Ph.D. degree in Chemistry from Princeton University in 1954.

He joined the Research and Development department of American Oil as a chemist in October, 1954. Dr. Clingman has published a number of articles in the field of petroleum and chemicals research and holds various patents.

Richard deY. Manning has been elected secretary of Commonwealth Oil Refining Co., Inc., Ponce, Puerto Rico, according to an announcement made by **Roy J. Diwoky,** president.

James L. Reeves has joined the technical staff of George Armistead and Co., as a chemical engineer. Reeves left Esso Standard Oil Co's. Baltimore refinery where he was a process engineer for the last 6 years. He will be located in Washington, D. C.

J. R. Stein has been appointed by The Dow Chemical Co. as general manager of its Louisiana division facilities now under construction on the west bank of the Mississippi River at Plaquemine, about 10 miles south of Baton Rouge.

Stein has been project manager of the new division since construction of facilities began in the spring of 1956. He started his Dow career in 1937 following his graduation from the University of Michigan with a B.S. degree in chemical engineering. He was associated with organic research and production engineering activities until 1940 when he was assigned to the Texas Division. At that time he established the division's production control department. In 1943 he was appointed an assistant general manager.

Stein was chairman of the Texas division operating board from the time it was formed in 1947 until assuming the Louisiana Division post in 1956.

K. H. Rowland has been named vice-president—production of Union Carbide Chemicals Co., division of Union Carbide Corp.

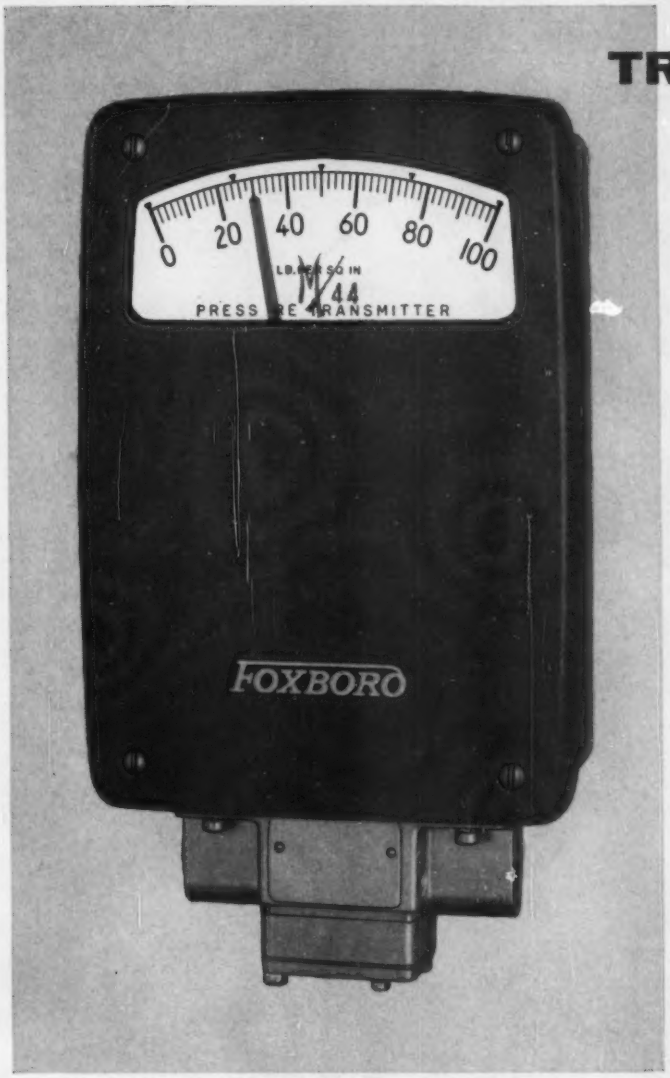
Rowland, who joined the Corporation in 1934 as an engineer in the South Charleston chemicals plant has been the company's works manager. He attended the University of Richmond and the University of Michigan, receiving his B.S. degree in chemical engineering in 1934 from the latter.

A. R. Vander Ploeg has been promoted to the managerial staff of The Texas Co's. Research and Technical department, Beacon, N. Y. He was formerly assistant director of research at Texaco's Port Arthur-Port Neches, Texas, research

For more data on advertised products, use Readers' Service Cards, last page.

read pressure up to 20 ft. away!

on the FOXBORO M/44 INDICATING PRESSURE TRANSMITTER



You can check pressure readings at a glance on the Foxboro Pneumatic Indicating Pressure Transmitter. Its open-face, horizontal, 4-inch indicator scale and eye-catching red pointer are clearly visible as far away as 20 feet.

But high readability is just part of the story. Actually, this instrument was engineered from the ground up. Makeshift arrangements have been eliminated, hung-on gauges are gone. Everything is included in one, neat, ready-to-install package.

Because the indicating pointer is direct-connected to element and transmitter, calibration is easy . . . and you can re-zero the transmitter externally. All M/44 components are standard, performance-proved Foxboro parts. This makes it easier to stock and service.

From its compact, drawn-steel case to its tough, polyester plastic cover the M/44 is the high-efficiency, low-cost pressure transmitter for centralized control and operation. All standard ranges.

Write for complete details. The Foxboro Company, 7412 Norfolk St., Foxboro, Mass.

FOXBORO
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INSTRUMENTATION FOR INDUSTRY

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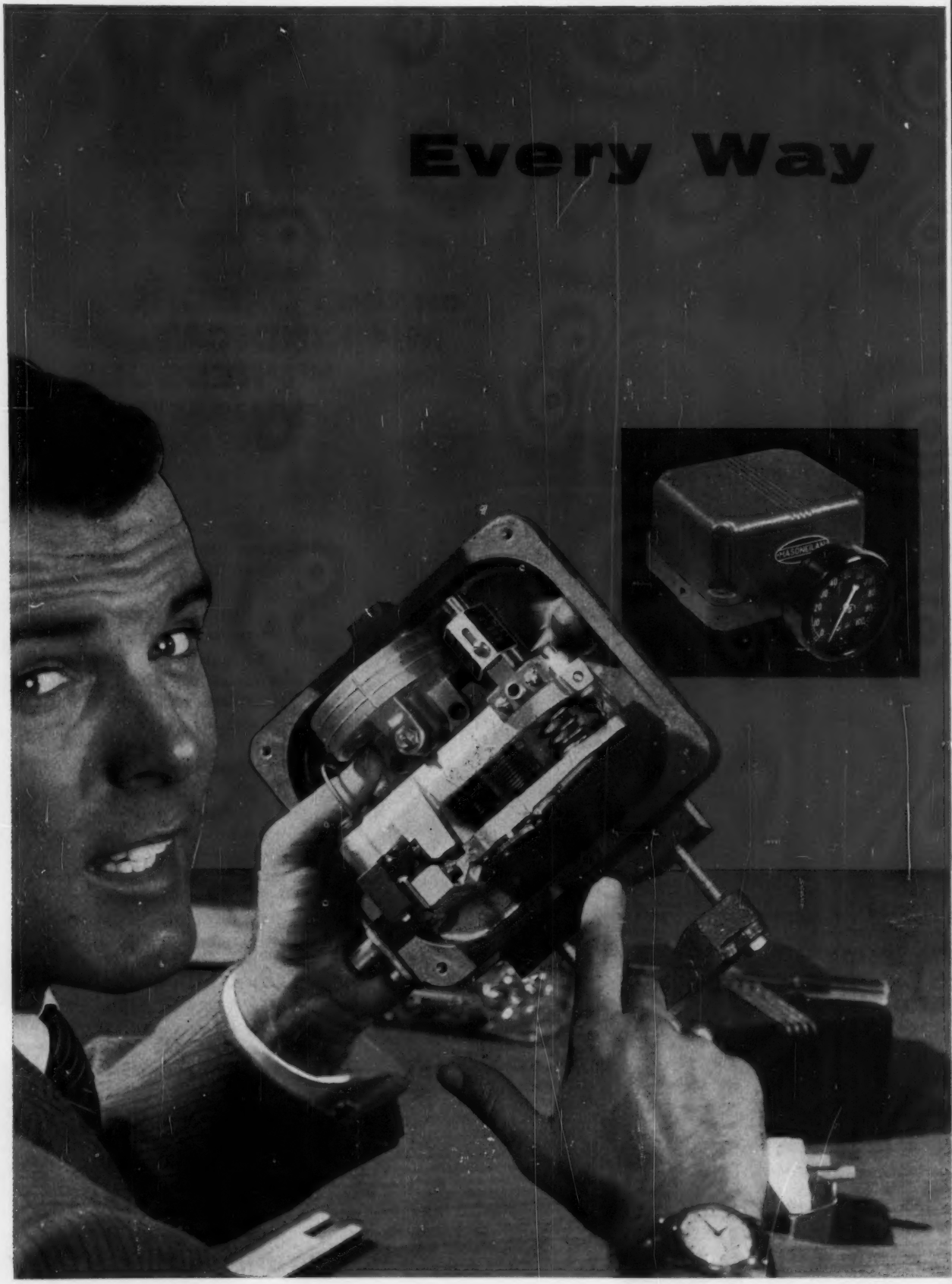
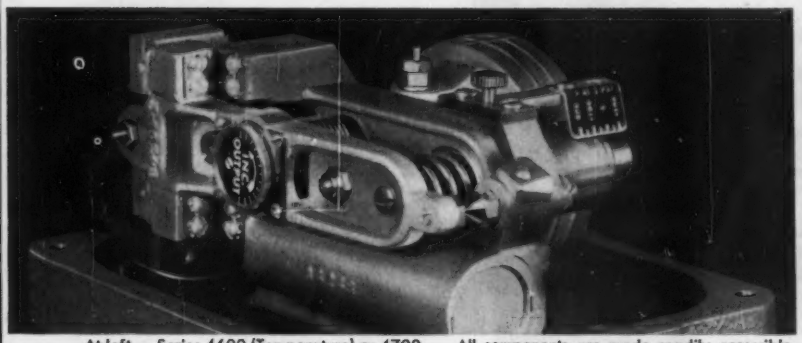

Every Way

You Look At It!

New Masoneilan Transmitter Offers High Performance, Ease of Installation and Maintenance



At left — Series 4600 (Temperature) or 4700 (Pressure) Transmitter is housed in a weatherproof aluminum case, with blue Hammertone finish. Weighs only about 8 lbs.

All components are made readily accessible by simply removing the cover. Simple, unitized construction makes everything compact, yet easy to adjust and maintain.

Derivative unit is easily mounted to base plate without tubing or fittings. Integral mounting of receiver gauge on front edge of base plate is also optional.

One look at the Masoneilan Temperature or Pressure Transmitter will show you its simple, compact and rugged design. All of the elements have been neatly tailored into a 7″ x 6″ area, only 3¾″ high; yet all adjustments are visible and easily accessible — performance is accurate and dependable.

Unitized construction is a major advancement. All sub-assemblies can be easily changed or removed individually, without disturbing the beam assembly. And the Derivative unit and Receiver Gauge may be integrally mounted on the base plate, requiring no tubing or fittings.

The new Masoneilan Transmitter is easily and quickly mounted to a pipe or flat surface — in any position found convenient, because the balanced beam eliminates zero shift.

This is your kind of instrument — built for dependable operation and easy maintenance! Send for new Bulletin which provides complete data and specifications.

MASON-NEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASSACHUSETTS

SEVENTY-FIFTH 75 ANNIVERSARY 1882-1957

Sales Offices or Distributors in the Following Cities:
New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia • Houston • Atlanta • Cleveland
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Three-point program works for motor oil producers at AMOCO Chemicals

1. **Research**—Petroleum chemists who have made important contributions in the field of additives are engaged in research programs to develop improved new petroleum additives for your use.

2. **Testing**—At AMOCO Chemicals your motor oil formulations are evaluated in one of the nation's top engine-test laboratories. Trained engineers supervise and conduct engine-test and laboratory work.

3. **Technical Service**—Sales engineers qualified by years of experience in this work are ready to help you with laboratory and field-test programs to develop motor oils and other petroleum products to meet your marketing requirements.

Put this three-point program to work. Let AMOCO Chemicals become your resource for petroleum additives. Your inquiry will receive an immediate response.

AMOCO CHEMICALS— A NEW RESOURCE

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Men in the Industry . . .

laboratories. His new assignment is assistant to management.

He received an A.B. degree in 1939 from Central College, Iowa and a B.S. degree in chemical engineering from Iowa State College in 1940. He joined Texaco in 1940 as a chemical engineer. His major work has been in the field of fuels research.

H. S. M. Burns, president of Shell Oil Co., New York, has been elected chairman of the board of directors of the American Petroleum Institute. He succeeds **Jake L. Hamon,** an independent producer of Dallas, Texas.

Burns

Burns was born in Aberdeen, Scotland, in 1900. During World War I he served with the Royal Artillery, after which he studied geology and chemistry at the University of Aberdeen. He later received his M.S. degree in mathematics and physics at Cambridge University. He worked in London, Venezuela, and Colombia and, in 1946, returned to the United States as senior vice president of Shell Oil Co., Inc. In 1947, he was elected president. In 1949, when a corporate reorganization resulted in the absorption of Shell Oil Co., Inc., by the holding company, he became president of the newly formed Shell Oil Co.

Other action by the API at its recent meeting in Chicago, saw **Frank M. Porter,** president of Fain-Porter Drilling Co., Oklahoma City, re-elected president of the Institute, and **H. W. Ferguson,** Humble Oil & Refining Co., elected vice president for refining.

Also, **B. B. Jennings,** chairman of the board of Socony Mobil Oil Co., New York, was re-elected treasurer, and **Willard M. Wilson,** assistant director of the American Petroleum Industries Committee, New York, was elected secretary, succeeding **Lacey Walker,** who retired earlier this year.

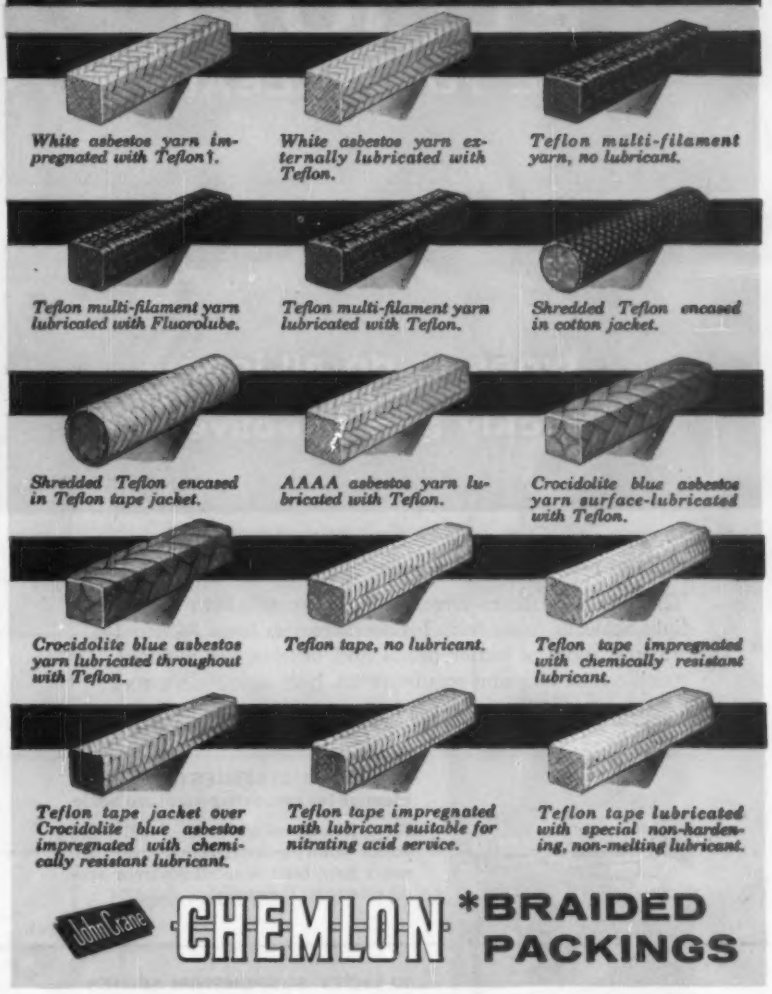
The Fifth World Petroleum Congress, Inc., board of directors has been set up to organize the first international oil congress ever to be held in the United States.

The event is expected to attract some 5000 scientists and technologist from over 35 countries to New York's Coliseum, where the six-day congress will open on May 31, 1959. The delegates will exchange information and ideas on the latest techniques being employed by the oil industry throughout the world.

The congress is being widely supported by the petroleum industry in the United States, and board members are: Reid Brazell, president and general manager of Leonard Refineries Inc., Alma, Mich.; F. S. Clulow, retired vice president of Shell Oil Co.; Ira H. Cram, director and senior vice president of Continental Oil Co.; G. A. Davidson, vice president and director of Standard Oil Co. of California; and C. Eugene Davis, general secretary of the congress, formerly vice president of Shell Oil Co.

Also, H. W. Field, vice president and general manager, Research and Develop-

15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES


White asbestos yarn impregnated with Teflon†.
White asbestos yarn externally lubricated with Teflon.
Teflon multi-filament yarn, no lubricant.
Teflon multi-filament yarn lubricated with Fluorolube.
Teflon multi-filament yarn lubricated with Teflon.
Shredded Teflon encased in cotton jacket.
Shredded Teflon encased in Teflon tape jacket.
AAAA asbestos yarn lubricated with Teflon.
Crocidolite blue asbestos yarn surface-lubricated with Teflon.
Crocidolite blue asbestos yarn lubricated throughout with Teflon.
Teflon tape, no lubricant.
Teflon tape impregnated with chemically resistant lubricant.
Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant.
Teflon tape impregnated with lubricant suitable for nitrating acid service.
Teflon tape lubricated with special non-hardening, non-melting lubricant.

John Crane CHEMLON *BRAIDED PACKINGS

Specific service conditions are always best handled with a packing designed for the purpose. This is especially true when it comes to the hard-to-handle liquids in the chemical, petrochemical and refinery industries.

For this reason John Crane has developed 15 individual field-proved types of Chemlon Braided Packings. Within this line there is a type and style that will meet any combination of service conditions and requirements.

1. All known industrial acids, alkalis or solvents.
2. Temperatures from −120°F to +600°F.
3. High or low shaft speeds, also valve stems.
4. Longer packing life due to lower coefficient of friction and non-raveling construction.

Send in your service condition and we will recommend a Chemlon Braided Packing best suited to your application. Request Bulletin P-325.

Crane Packing Co., 6420 Oakton St., Morton Grove, Ill. (Chicago Suburb).
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†*T. M. for DuPont Teflon* *T. M. for the Best in DuPont Teflon

CRANE PACKING COMPANY

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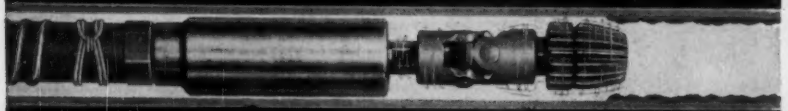
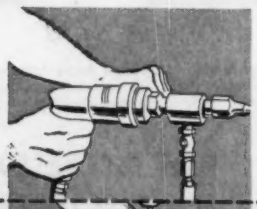
SMALL TUBE CLEANERS



types to do all jobs
quickly and effectively

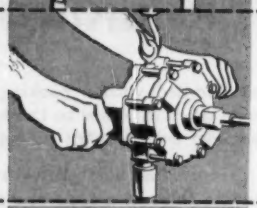
ELLIOTT 600 SERIES for small tubes—straight or curved

These air- or steam-driven motors are excellent for routing light scale in tubes with inside diameters from 5/8" to 1¾". Various types of cutter heads and brushes are available for specific tube cleaning requirements.



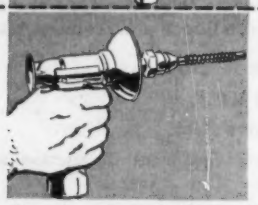
ELLIOTT 5100 SERIES lightweight cleaner for removing medium scale

Air-driven motor with trigger action for motor control, finger-action valve for water flow, built-in speed governor and oil reservoir. Two sizes.



ELLIOTT SUSPENSION SERIES for heavily scaled straight tubes

Air, steam, or electric motor drives shaft fitted with drill or brush head. Motor is suspended outside, shaft and head enter tube.



ELLIOTT JIFFY GUN for extra-fast cleaning of light accumulations

Simply insert nozzle into tube and push. Released air or water pressure shoots nylon brushes or rubber plugs through condenser or heat exchanger tubes. For tubes ½" to 1".

For details on Elliott tube cleaning and maintenance equipment, contact Elliott District Office or write Elliott Company, Lagonda Division, Springfield, Ohio.

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ELLIOTT Company
Headquarters for Tube Cleaners and Expanders

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Men in the Industry . . .

ment department, The Atlantic Refining Co.; W. C. Kinsolving, president, Sun Pipe Line Co. and Sun-Canadian Pipe Line Co.; Dr. W. E. Kuhn, general manager of the Research and Technical department of The Texas Co.; John W. Mecom, Houston; Dr. Jerry McAfee, vice president, Gulf Oil Corp.; E. B. McConnell, director and vice president, Standard Oil Company (Ohio); E. V. Murphree, president of Esso Research and Engineering Co. and president of the Congress; and H. B. Nichols, senior vice-president, California Texas Oil Co. Ltd.

Also, Carl E. Reistle, Jr., director and executive vice president, Humble Oil & Refining Co.; J. K. Roberts, director and vice president, Standard Oil Co. (Indiana); and Dr. J. C. Zimmer, technical advisor, research department, Socony Mobil Oil Co., Inc.

Myrle M. Perkins, engineering executive, has joined Bechtel Corp., international engineering and construction firm with headquarters in San Francisco.

Perkins

As executive engineer, Perkins will be active in business development, primarily in the refinery and petrochemical fields.

He has been associated with the M. W. Kellogg Co., New York, for the past 21 years. A graduate of Massachusetts Institute of Technology with B.S. and M.S. degrees in chemical engineering, he is a licensed professional engineer in New York, Texas and California.

M. H. Robineau has been elected president of the Independent Refiners Association, and **W. E. Slaughter** has been elected vice president. Other officers elected at a recent meeting included **James P. Dunnigan,** secretary-treasurer; **Norman L. Meyers,** assistant secretary; and **E. J. Dryer,** assistant secretary.

Those elected to the board of directors were M. H. Robineau, president, The Frontier Refining Co.; W. E. Slaughter, Jr., president, Aurora Gasoline Co.; R. P. Hargis, president, Premier Oil Refining Co. of Texas; Robert Anderson, president, Malco Refineries, Inc.; Rex Blazer, Ashland Oil & Refining Co.; Richard B. Kahle, president, Eastern States Petroleum Co., Inc.; Elmer Ericksen, president, Northwestern Refining Co.; Raymond C. Tollett, president, Cosden Petroleum Co.; and William J. Carthaus, president, Great Northern Oil Co.

Frederick G. Sawyer has been appointed vice-president of Jacobs Engineering Co., Pasadena, Calif. Dr. Sawyer was formerly with The Ralph M. Parsons Co., Los Angeles, in chemical business development and as manager of public relations and advertising.

D. G. Smith has been named general manager and **Dr. D. A. Howas** assistant general manager of British Petroleum Co., Ltd.'s newly established Petroleum Chemicals department.

The formation of the Petroleum Chemicals department will be accompanied by some changes in the Refineries and Tech-

Refractory Castables are SPECIALIZED

Which are best to use in refinery units?

Naturally, the type of refractory castable selected depends upon the specific service. B&W makes a line of specialized refractory castables which are being widely used in catalytic reformers and catalytic cracking units, as well as in furnaces, ducts and stacks. For easy reference, here are some typical applications together with the recommended B&W Refractory Castables:

APPLICATION	DESIRABLE PROPERTIES	RECOMMENDED B&W CASTABLES
Linings of catalytic reformers	Extremely low iron content, extra high strength. Extremely low iron content, plus good insulation. Low iron content, high temperature use limit.	Kaocrete LI Kaolite LI Kaocast
Lining desulphurizers	Good workability	Kaocrete B
Transfer lines and regenerators of catalytic cracking units	Extra abrasion and erosion resistance.	Kaocrete D
Heads of reactors and regenerators	Plasticity, excellent workability.	Kaocrete B
Insulating furnace floors	Good insulation, light weight	Kaolite-20 Kaolite-22
Tube sheets	Good insulation, light weight	Kaolite-20 Kaolite-22
Burner blocks	High temperature use limit, refractoriness and spalling resistance.	Kaocast
Openings where doors and other points are subject to mechanical abuse	Extra abrasion and erosion resistance	Kaocrete D
Furnace doors	Good insulation, light weight	Kaolite-20 Kaolite-22
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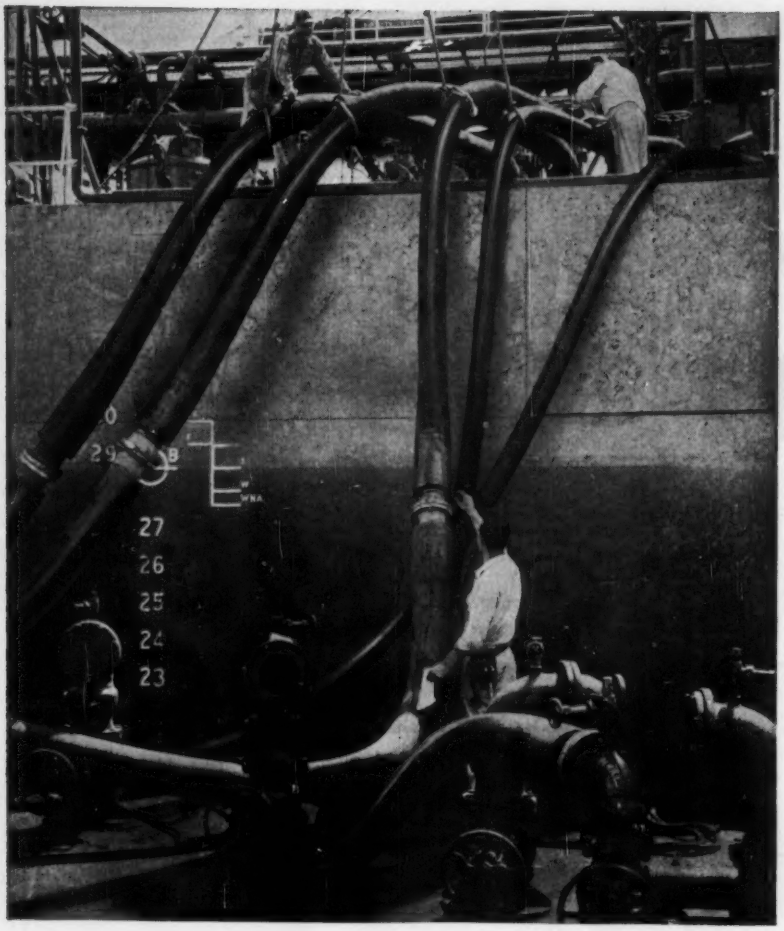

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Men in the Industry . . .

nical department, including the appointment of **M. A. L. Banks** as general manager, following the appointment of **C. E. Spearing** as a director of BP Trading, Ltd. **S. E. Adey** is to be deputy general manager, and assistant general managers will be **J. Moffat** and **D. W. K. Barker,** the former being responsible for United Kingdom and Continental refineries and Barker for Eastern and Commonwealth refineries. **P. Docksey** is to be co-ordinator, Research and Development.

George T. Culp has been appointed head of the Employee Relations group of Creole Petroleum Corp.'s New York office. Culp replaces **Milton C. Hagen** who transferred to Standard Oil Co. (New Jersey) as overseas advisor.

Culp joined Creole in 1946 as a training supervisor at the Caripito refinery in Venezuela. He spent the next eleven years working with Creole in Venezuela helping to start the company's training program and as an industrial relations supervisor.

Paul D. May has been promoted to senior chemist in the Research and Development department of American Oil Co. May is a graduate of the University of Frankfurt and Sorbonne and has attended Princeton University. He joined the Research and Development department of American Oil in September, 1945.

J. B. Saunders, Houston, and **Breene M. Kerr,** Oklahoma City, have been elected to the board of directors of Kerr-McGee Oil Industries, Inc.

Saunders is president of Triangle Refineries, Inc., Houston, a company acquired this spring by Kerr-McGee. A native of Hillsboro, Texas, he began his career in the oil industry as a shipping clerk for Imperial Refineries, and resigned as general sales manager of that company to organize Triangle in 1937.

Kerr is a son of Sen. Rob't S. Kerr, founder and chairman of Kerr-McGee.

James R. Burton, recent graduate of Texas Technological College, has joined The Texas Co. as a chemist. He begins his professional career at Texaco's Research and Development Laboratories at Port Arthur, Texas.

Burton completed all requirements for his M.S. degree in chemistry in August, 1957. He received his B.S. degree in chemistry from the same school in 1955.

Frederick W. Fink has been named chief of the Corrosion Research division at Battelle Memorial Institute, **Dr. B. D. Thomas,** director, announced recently.

Fink has specialized in corrosion studies, particularly those related to nonferrous metals and stainless steels, since first joining the staff of the Columbus, Ohio, research center in 1938. His studies have resulted in publications covering many diverse corrosion problems.

After obtaining his engineering degree at Cornell University in 1935, Fink was, for two years, engaged in graduate study in Germany and England. He received his M. Sc. degree from the University of Cambridge, England.

Donald G. Fine, a graduate of Kansas University, has joined The Texas Co. as a chemical engineer at the Texaco Re-

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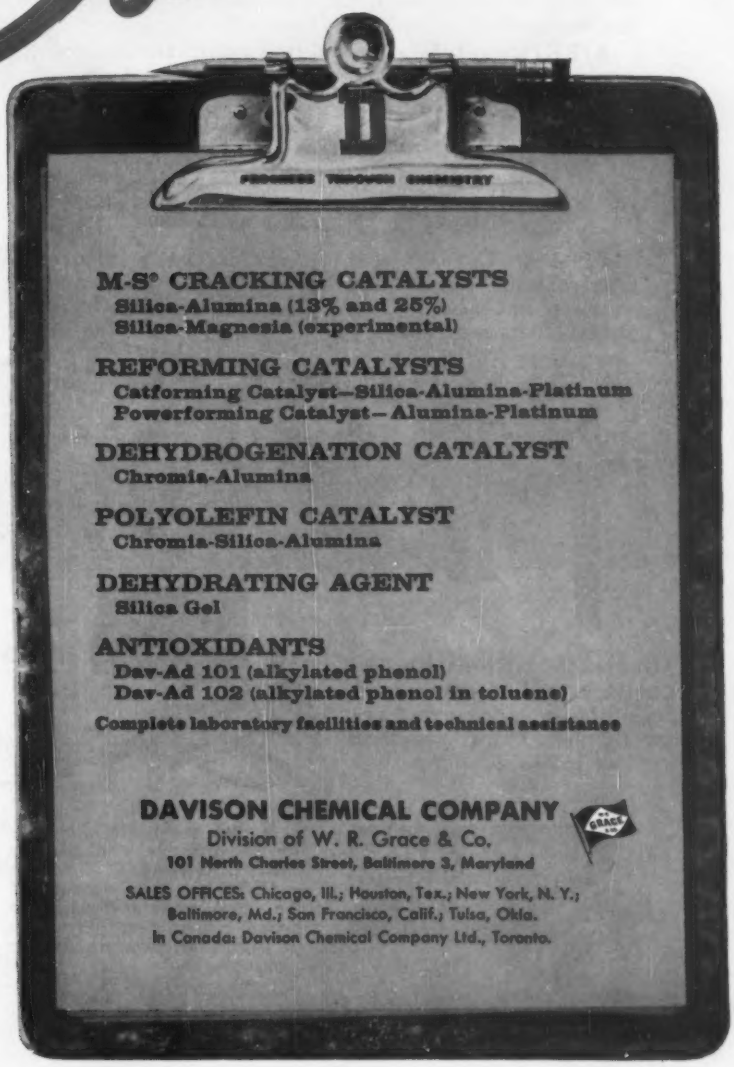

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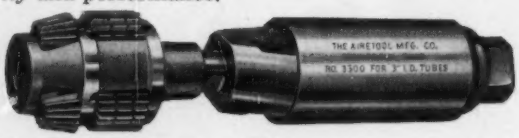

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Men in the Industry . . .

search and Development Laboratories, Port Arthur, Texas.

Fine will do research and development work. He received his B.S. degree in chemical engineering in June, 1955.

Charles Newton Kimberlin, Jr., assistant director of the Esso Research Laboratories, Baton Rouge, and an authority on petroleum chemistry, has won the 1957 Southern Chemist Award of the American Chemical Society's Memphis section.

Kimberlin

The gold medal, given annually for distinguished service to the profession of chemistry in the Southern states, was presented to Kimberlin at a banquet in the Washington Duke Hotel, Durham, N. C.

The 1957 medalist was chosen "in recognition of 24 years outstanding research in the fields of catalysis and petroleum chemistry". Kimberlin's contributions range from early advances in petroleum lubricants to improvements in modern petrochemical processes. His pioneering research with greases and similar materials won him world-wide recognition.

The powerforming process for making high octane fuel was developed with the aid of Kimberlin, who also is credited with major contributions to the development of a silica-magnesia catalyst having important applications to gasoline production.

Kimberlin received his B.S. degree from Louisiana College in 1931 and his M.S. degree from Louisiana State University in 1933. He joined the Esso Laboratories in Baton Rouge as a research associate in 1933, became a senior research associate in 1948 and recently was named to his present position.

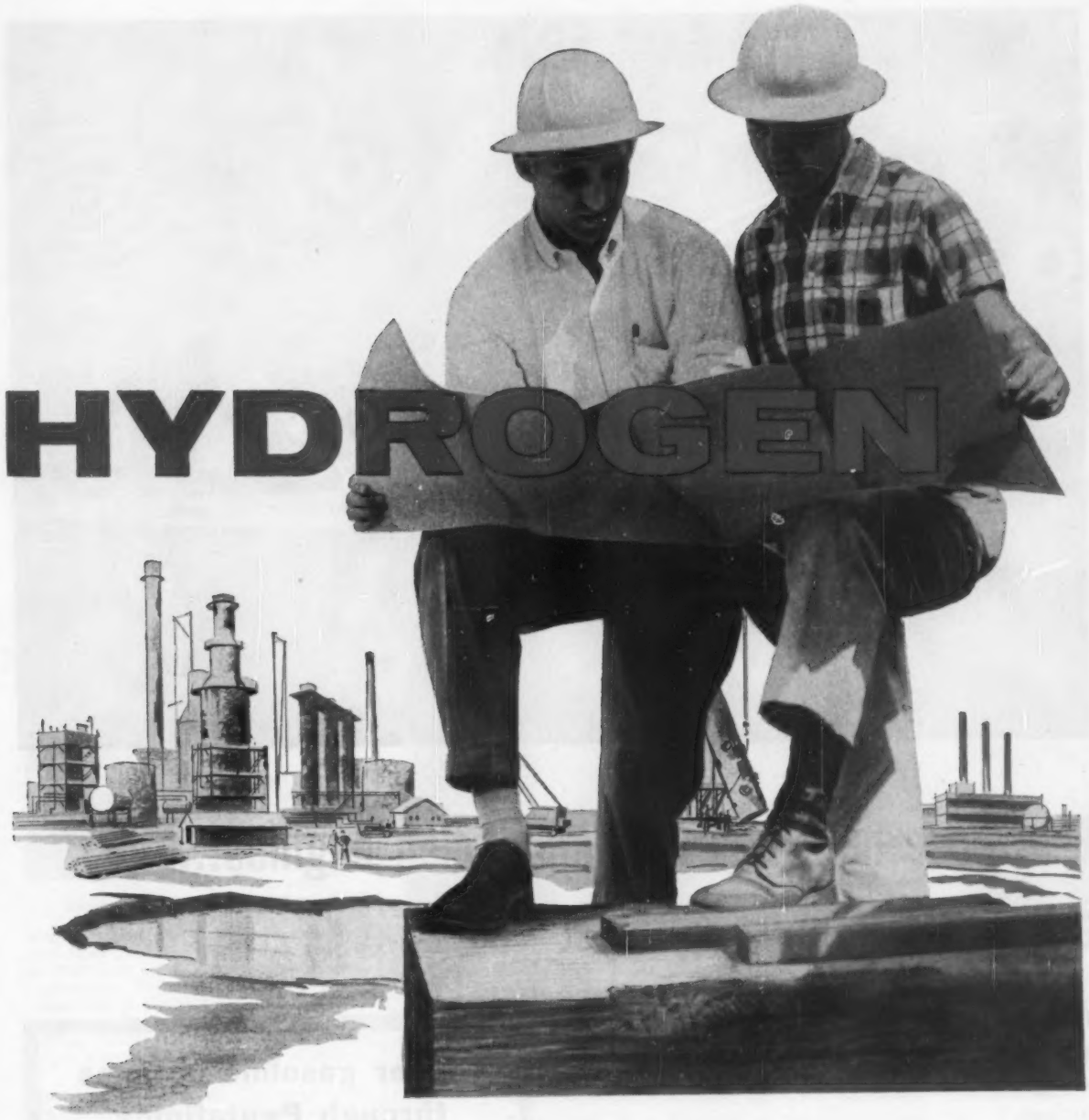
Fred W. Obermann. Pittsburgh, M.S. degree in chemical engineering from Carnegie Institute of Technology in 1957, has become a member of the technical services department of Monsanto Chemical Co.'s Organic Chemicals division at the John F. Queeny Plant, St. Louis.

John M. White, Little Rock, B.S. chemical engineering, University of Arkansas in 1957, has become a member of the technical services department of Monsanto Chemical Co.'s Organic Chemicals division at Monsanto, Ill.

D. E. Stines has been elected a director of Creole Petroleum Corp.

Stines, who was elected a vice president of the company in September, 1956, graduated as a mechanical engineer from Cornell University in 1929, and joined the Standard Oil Co. (New Jersey) organization in the same year as a student engineer at the Bayway refinery.

In 1944 Stines was appointed assistant manager of the Export Sales department of Creole Petroleum Corp in New York. He remained in this assignment until 1947, when he transferred to the Jersey



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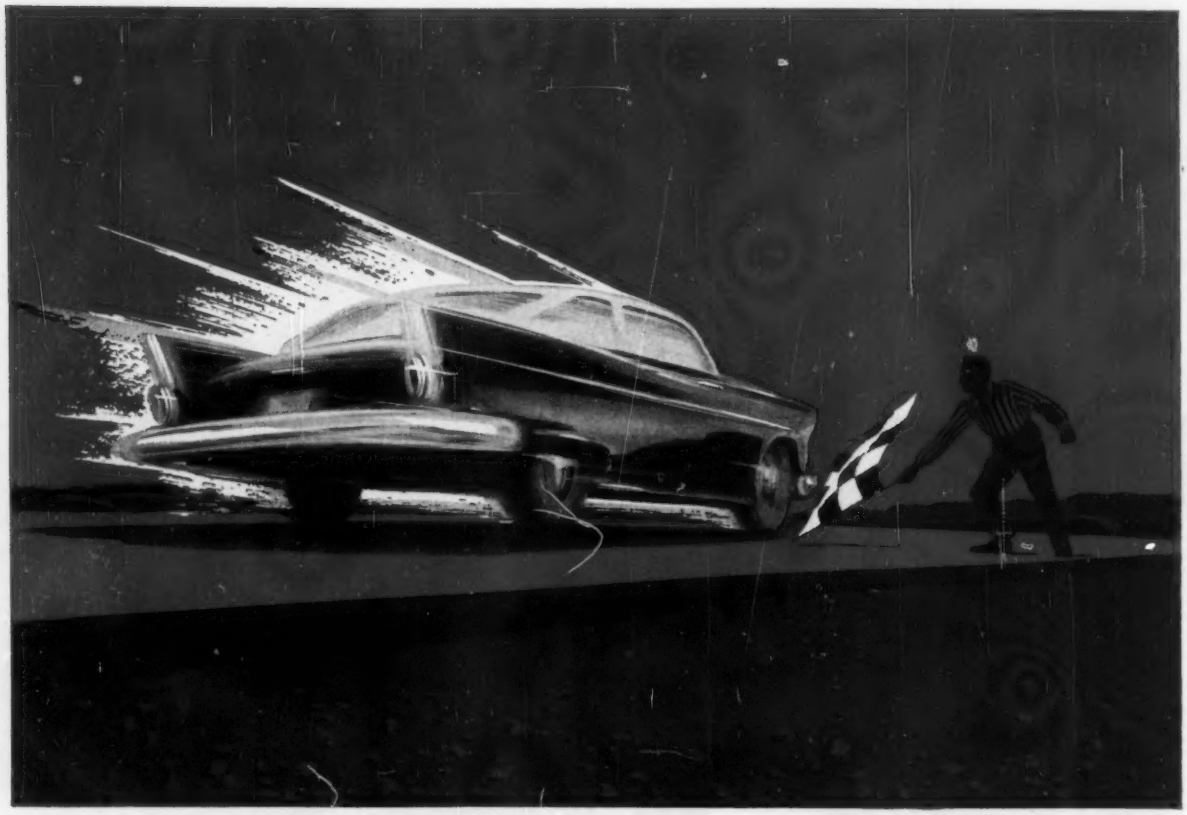

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Men in the Industry . . .

Standard Coordination and Economics department in New York as Head of the Coordination division.

He remained in this position through 1952 when he was appointed vice chairman of the Coordination Committee for Europe. From 1955 until September, 1956, Stines was special adviser on refining matters for Esso Petroleum Co., Ltd. in London.

Saul Gilbert has been appointed chief process engineer of Société Francaise des Techniques Lummus, Paris, the French branch of The Lummus Co.

Gilbert obtained a B.A. degree in chemistry from U.C.L.A. in 1940, a B.E. degree in chemical engineering from U.S.C. in 1942, and after four years with Tide Water Associated Oil Co. at the Avon Refinery, returned to U.S.C. for his M.S. degree in chemical engineering, which he received in 1948. From 1947 to 1952 he was process engineer for the Refinery Maintenance Co., Compton, Calif., joining Lummus in the fall of 1952.

Ronald E. Cannon has been named secretary of the Natural Gasoline Association of America. Also, **William F. Lowe** was appointed executive director and treasurer. Lowe has been secretary-treasurer of the Association since 1934.

Cannon

Prior to Cannon's election he was a technical editor for the McGraw-Hill Publishing Co. of New York with offices in Houston.

Cannon, a native of Beaumont, Texas, attended Tulane University and was graduated from Louisiana Polytechnic Institute in 1948 with a B.S. degree in mechanical engineering. Following graduation, he joined the Gulf Oil Corp. and served as project engineer in that company's Port Arthur, Texas, and Philadelphia refineries before joining McGraw-Hill in 1956.

Thomas R. Winkle, Columbus Ohio, B.S. chemical engineering, Ohio State University in 1957, has joined the technical service section of Monsanto Chemical Co.'s Plastics division at Texas City.

Tommy E. Graham, Stillwater, Okla., M.S. chemical engineering, Oklahoma A&M in 1957, has joined the pilot plant group, research department of Monsanto's Plastics division at Texas City.

Frank C. Somers, a section head in the construction engineering division of Esso Research and Engineering Co., has been appointed assistant manager of Esso Engineering's newly established office in The Hague, Netherlands.

During his company service he has traveled extensively, this past summer being assigned to a refinery project at Cartagena, Colombia. He also has had assignments in Canada and Venezuela dealing with refinery work and consultation programs.

Somers began his Esso career in 1939 as a student operator in Aruba. In 1939 he

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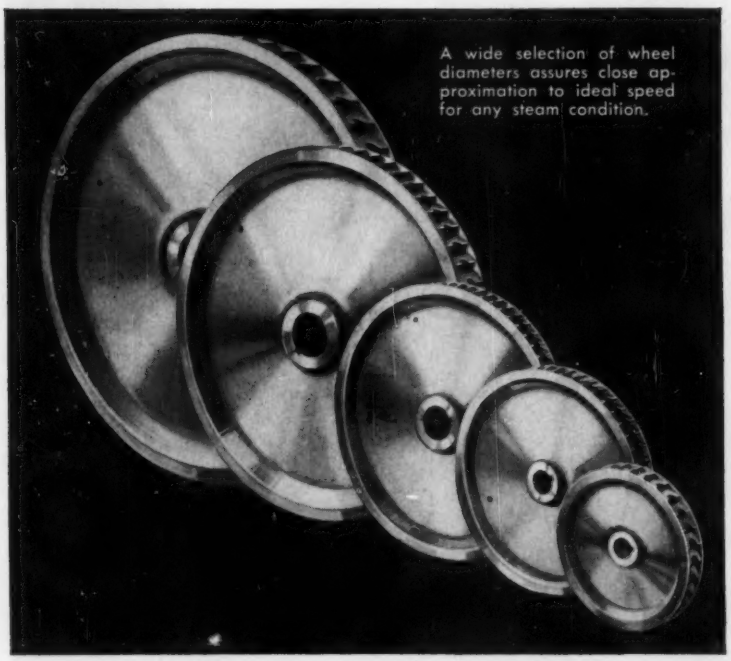

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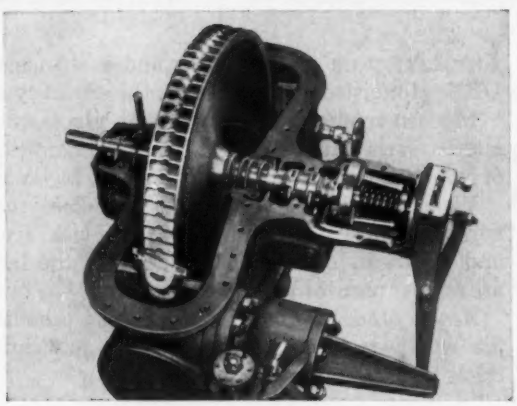

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Men in the Industry . . .

joined Atlantic Refining Co. in Philadelphia as manager of engineering research. He returned to Esso Research in January of this year as assistant supervising engineer of his division's procurement section.

A graduate of Duke University, where he earned a B.S. degree in electrical engineering, Somers received an M.S. degree in the same subject from Massachusetts Institute of Technology.

John H. Wright, Dayton, Ohio, B.S. mechanical engineering, University of Dayton in 1956, has joined the engineering research section, research department of Monsanto's Research and Engineering division at Dayton, Ohio.

William L. Bolles has been appointed an engineering manager in the engineering department, Lion Oil Co., Division of Monsanto Chemical Co.

Bolles, who has been assistant manager in charge of process design in the engineering department of Monsanto's Plastics division at Texas City since 1954, transferred to Lion in September. In his new position he will be stationed at El Dorado, Ark.

Bolles graduated from Washington University in 1941 with a B.S. degree, and received an M.S. degree from the University of Missouri in 1943, both in chemical engineering.

Tom Dougherty, *Petroleum Information,* Denver, Colo., is the new president of the Association of Petroleum Writers. He was elected at the annual dinner meeting held in connection with the 37th annual meeting of the American Petroleum Institute in Chicago.

Dougherty succeeds **Frank O. Hall,** *Record-News and Times,* Wichita Falls, Texas, who was named chairman of the executive committee.

James B. Taylor has been elected a director of Signal Oil and Gas Co., it was announced by **Samuel B. Mosher,** president of the company. Taylor, who has been with Signal since 1926, is also assistant manager of the company's gas department.

Taylor

Taylor graduated from Stanford with an A.B. degree in electrical engineering in 1926. He joined Signal that same year at Signal Hill, Calif. In 1935 he became chief gas engineer for all Signal natural gasoline plants, and was named assistant manager of the gas department in 1942.

Taylor is a past president of the California Natural Gasoline Association and the Southern California Meter Association.

Robert R. Gumaer has been promoted to senior chemical engineer in the Research and Development department of American Oil Co. it was announced by **Dr. A. A. O'Kelly,** department director.

Gumaer is a graduate of the University

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Men in the Industry . . .

of Tulsa where he received a B.S. degree in chemical engineering in 1937. He also did one year of graduate work at the University of Tulsa while serving as an instructor.

Dr. Robert E. Conary has been named to a new assistant manager post in the Research division of the Research and Technical department of The Texas Co. He will be responsible for research activities in the field of chemicals. Dr. Conary was formerly director of research at the Texaco Research Center, Beacon, N. Y. He will be located at Research and Technical department headquarters in Beacon.

Dr. Conary received his B.Ch.E. degree from the University of Minnesota in 1934 and was awarded his Ph.D. degree at the University of Wisconsin in 1938. He joined the Texaco Research Center on July 1, 1938.

Rudolph Cubicciotti, vice president of L. Sonneborn Sons, Inc., New York, has been elected president of the National Lubricating Grease Institute. His one-year term will coincide with the 25th anniversary of the Institute, which represents 95 percent of the lubricating grease manufacturers in the United States.

Cubicciotti

Cubicciotti has served since 1943 with L. Sonneborn Sons, Inc. He joined the company after leaving Union Oil Co. of California, where he held a top sales position.

He was graduated from the University of California with a B.S. degree in chemical engineering.

Previously, Cubicciotti served as vice president of the NLGI. He is also on the Lubrication Committee of the American Petroleum Institute of which he was Chairman in 1954.

J. D. Fosque has been elected vice president of California Texas Oil Co., Ltd. and will direct marketing and refining service activities on behalf of all Caltex companies in Europe and Africa. Formerly managing director of Caltex (India) Ltd, Fosque returned to New York in 1954 as European general manager. He remains in New York in his new assignment.

Fosque

Rowland S. Stanfield, refinery representative at Tidewater Oil Co's. Delaware refinery, has retired following more than 37 years of service.

Stanfield joined Tidewater in 1920 as an engineer at Tulsa. The following year he was appointed assistant refinery superintendent at the Drumright, Okla. refinery, where he became superintendent in 1922. He was named chief engineer at the former Bayonne refinery in 1935.

In 1955 he was appointed refinery rep-

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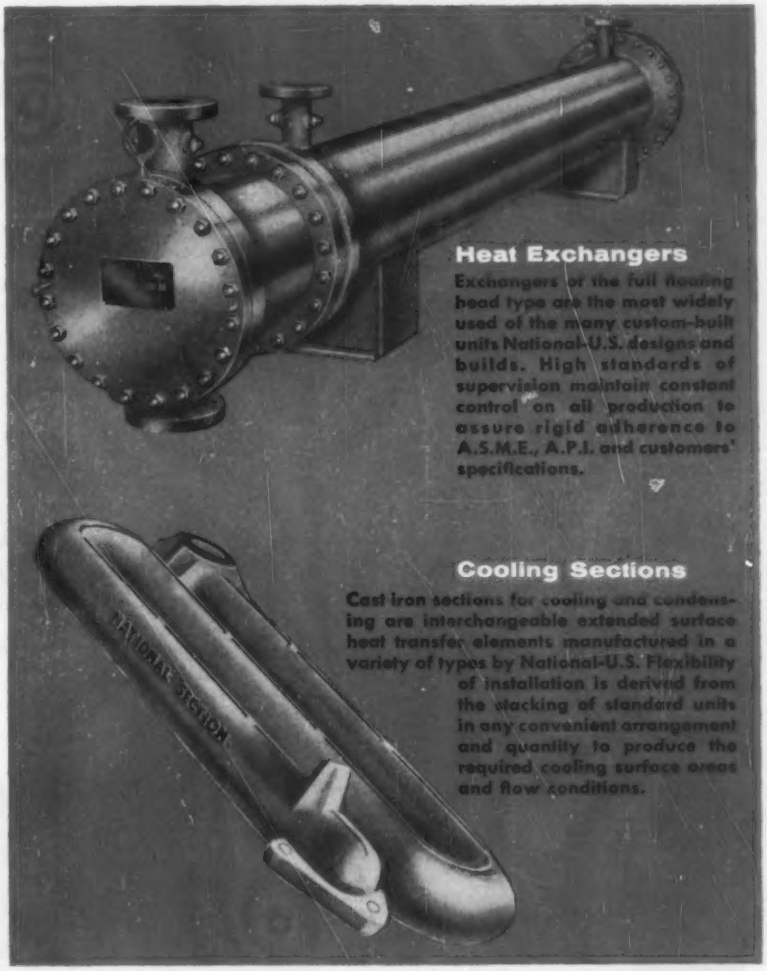
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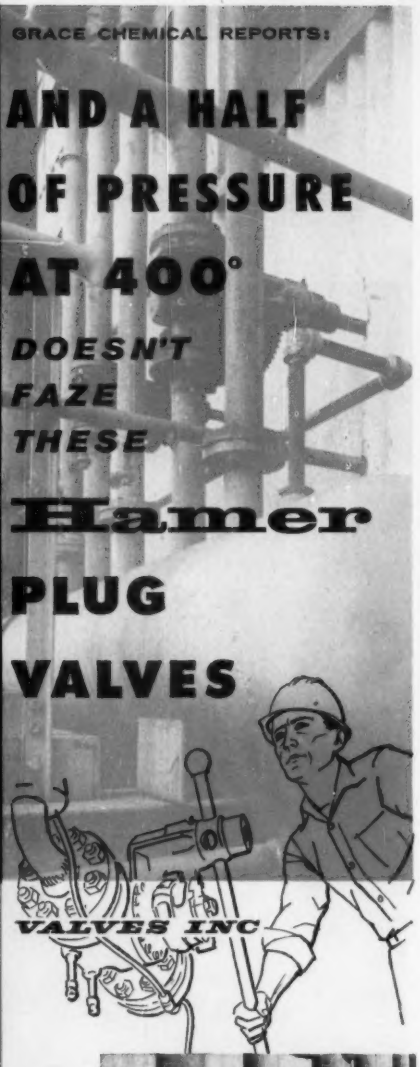

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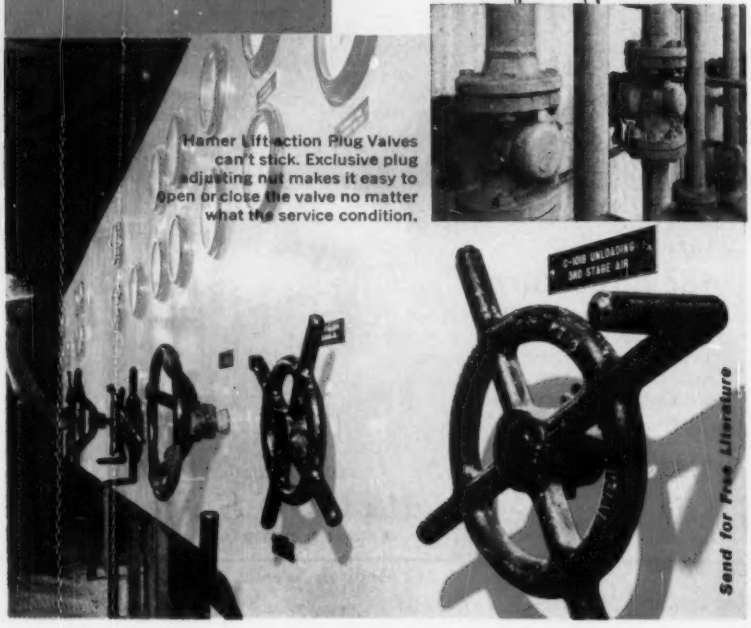

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Men in the Industry . . .

resentative and has participated in various community and public relations activities for Tidewater as well as in civic and community affairs.

Dr. E. B. Evans, chief chemist of Esso Research, Ltd., has been awarded the Eastlake Medal of the Institute of Petroleum for outstanding services to the Institute. He has been active on a number of committees of the Institute, and has served as a member of council since before the war. He is now a vice-president and also honorary editor of the Institute's publications.

Walter Sullivan has been named section head in charge of field engineering activities for the European engineering office of Esso Research and Engineering Co. Sullivan is attached to Esso Engineering's newly-established office in The Hague, Netherlands.

A graduate of the University of Maine, where he earned a B.S. degree in mechanical engineering, Sullivan has been with the Linden research organization since 1946. During his company service he has been concerned chiefly with field engineering activities.

He has been a resident engineer at Baltimore, Caratagena, Columbia, and Fawley, England. In February of this year he was assigned to Antwerp, Belgium, as construction coordinator.

–Deaths–

J. A. (Jap) Neath, 60, chairman of Humble Oil & Refining Co., since 1955, died of a heart ailment in his home in Houston. Having spent 44 years in the oil industry, Neath had served Humble since 1919.

W. C. Stevenson. 58, Union Oil Company of California vice president for industrial relations, died recently at La Jolla. Following his graduation from Stanford University in 1923 he joined Union Oil. In 1946 he was made assistant to the executive vice president and in 1952 elected vice president in charge of industrial relations.

Charles E. Finney, Jr., 67, retired president of Salt Lake Refining and Salt Lake Pipe Line Companies, died after a heart attack.

Finney was elected Standard Oil Co. of California vice president for industrial relations in 1946, and president of Salt Lake Refining and Pipe Line Companies in 1948. He retired in 1953.

William H. Pinckard, 63, retired board chairman of California Texas Oil Co., Ltd., died recently in Palo Alto, Calif. Pinckard had retired in April 1957. His career began in 1917 when he joined The Texas Co. at Port Arthur.

Lawrence Hill Rushmer, district manager of Ras Tanura, who was in his thirty-fifth year with Aramco and affiliated companies, died at the home of his daughter in Orinda, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

When piping changes direction, protect process equipment with

ZALLEA SELF EQUALIZING UNIVERSAL EXPANSION JOINTS

Zallea Self Equalizing Universal Expansion Joints absorb any movement in any direction . . . axially, laterally, angularly, or any combination of these . . . making them ideal for protecting process vessels and rotating equipment from thermal expansion of connected piping.

When there is a leg or 90° offset to a long run of pipe, one Zallea Universal Expansion Joint will frequently take care of the entire system.

Under conditions of low load requirement for anchors or equipment . . . or when compressive loading in pipe walls must be kept to a minimum . . . Zallea Universal Expansion Joints are the most economical answer to the problem. They absorb the internal pressure thrust. The piping system need only carry the relatively small deflection loads.

Many types of Zallea Tied Expansion Joints are designed especially to absorb lateral deflection or rotation when there is pressure in the line. Universal, Modified Universal, Hinged, Gimbal, Pressure Balanced and Universal Pressure Balanced Expansion Joints give you a choice of the type best suited to your particular application.

Get the complete story of Zallea Expansion Joints in our new 72-page manual. Write, on your company letterhead, for your copy of Catalog 56. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

Zallea
expansion joints

Zallea Brothers • Wilmington 99, Delaware

World's largest manufacturer of expansion joints

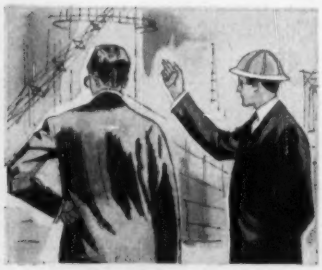
24" dia. Zallea Universal Self Equalizing Expansion Joints in service lines of the engine test facility of a West Coast aircraft manufacturer.

CONTRACT ENGINEERING with a difference

from initial negotiations . . . to "on stream" you deal with Badger principals

You first make contact with Badger through a Key Man as he works with you and your engineering staff in pinpointing your processing and economic problems.

The Key Man, acting in your behalf, takes your problem to Badger engineering specialists for preliminary study and evaluation.



With recommendations approved and construction underway, the Badger Key Man is still on the spot coordinating activities. He remains in charge until your project is complete.

AN engineering project handled by Badger is a group effort involving many highly developed skills. And from first contact until the project is complete these experienced specialists are headed by a Badger Key Man. More than just a sales engineer, he is always a Badger principal — always the Key Man in the execution of the project.

This sensible operating policy, which channels project liaison, coordination and administration through a company principal, is important to you and your project. You will find that most policy level decisions can be made on the spot as situations require. Further, the Key Man's depth of experience means you deal with an executive-engineer who talks your language — knows your problems and how to find their solutions.

Many clients say Key Man Policy is the Badger difference that makes the difference. Wouldn't it be wise to inquire how it could serve to make your projects more successful?

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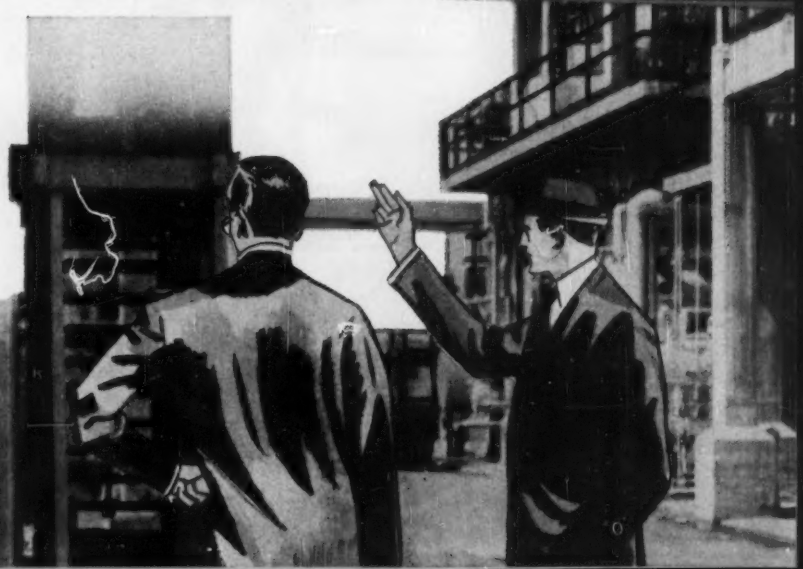
ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS



What Suppliers Are Doing . . .

Simmons

Wendell F. Simmons has been appointed regional vice president of Blaw-Knox Co. in the New York-Philadelphia area, in his new position, Simmons will represent management in the company's relationships with civic and municipal organizations, and in co-ordinating contacts with the press and the public in the eastern regional area.

Simmons will continue to maintain general customer relationships for the company in the area; and to advise and assist sales personnel in direct sales efforts and customer contacts, in the development and marketing of new products, and in improvement of the company's distribution system.

A native of Huntingdon County, Pa., Simmons has been associated with Blaw-Knox since 1928. He has been successively district sales manager of the Philadelphia Office, district manager of the Hadden Heights, New Jersey and New York Offices, and eastern regional representative for the New York-Philadelphia area.

Davis

William H. Davis has been named chemical sales manager, Petro-Tex Chemical Corp., Houston. Davis joined Petro-Tex in 1955 as director of sales development after previous association with Monsanto Chemical Co. and Magnolia Petroleum Co. Petro-Tex is jointly owned by Tennessee Gas Transmission Co. and Food Machinery & Chemical Corp.

Kotula

Louis F. Kotula, Glen Ellyn, Ill., was recently appointed a sales engineer for the Chicago office of B-I-F Industries, Inc., Providence, R. I.

Kotula received his B.S. degree from the University of Illinois in 1942 and has had several years training in business management. He is a registered professional engineer in Illinois, and has been a staff engineer in charge of sales and estimating, and a purchasing agent before employment at B-I-F Industries.

Clote

John Clote, formerly field engineer for the Tretolite Co., division of Petrolite Corp., McPherson, Kas., has been named assistant advertising manager of Petrolite Corp., assigned to the St. Louis headquarters. Clote joined Tretolite in 1952 at McPherson. He is a graduate of the University of Missouri School of Journalism, and served as district editor for the *Oil and Gas Journal* at Tulsa and later at Houston.

Moffatt

John P. Moffatt, Jr., has been appointed director of quality control, Central Manufacturing Division, Consolidated Electrodynamics Corp. A graduate of the California Institute of Technology with a B.S. degree in mechanical engineering, Moffatt also has an M.S. degree in business administration from Stanford.

He has been in CEC's quality control department since joining the company in 1952. He was a test engineer, tooling group supervisor, and data analysis supervisor prior to appointment as assistant director in January, 1956.

John Robell has joined the sales engineering staff of Badger Manufacturing Co., Cambridge, Mass.

Mr. Robell has degrees in chemical and mechanical engineering from the University of Ghent, Belgium, as well as 25 years research and development experience in the U. S. and abroad. He is credited with several patents in inorganic chemistry and process equipment and pioneered in the development of flame reactions.

In addition to his management and engineering responsibilities in the U. S., Robell has investigated plants in Germany for the U. S. Government and plants in France, Belgium, Holland and South America.

Robell is a Fellow of the American Association for the Advancement of Science, a member of the American Institute of Chemical Engineers, the American Chemical Society and other technical and scientific groups.

Robell

Don L. Warner has been appointed sales representative for the Marsh Instrument Co., Philadelphia. He will serve eastern Pennsylvania, New Jersey, District of Columbia, Maryland and Delaware. The new Marsh sales office in Philadelphia will also be under his direction.

Warner is a graduate of Illinois Wesleyan University and has been associated with the Marsh sales staff for the last eight years.

Warner

Burton S. Payne, Jr., has been named to head the metallurgical research and development group in the research division of the Pfaudler Co. A graduate of Rensselaer Polytechnic Institute, Payne joined Pfaudler in June 1956 as a metallurgist.

Payne is taking over the duties and responsibilities formerly held by **Richard E. Avery,** who is now doing quality control work on the staff of works manager **E. W. Zoller.** Payne is a member of the American Society of Metals, Acacia Fraternity, Tau Beta Pi and Phi Lambda Upsilon.

Payne

J. B. Spurlock has been appointed a sales representative of Flori Pipe Co., Houston. He will use Houston as a base of operations and assist Paul D. Broussard in serving nine states.

Spurlock, a native of Houston and Baytown, Tex., and a mechanical engineering graduate of the University of Houston, has had 30 years of experience in fabrication engineering and sales, ranging from shop work to sales administration.

Spurlock

Arthur F. Uhrlandt has been appointed to the newly created post of director of field sales for Crouse-Hinds Co., Syracuse, as announced by **John R. Tuttle,** president and chairman of the board. Uhrlandt will direct and coordinate all activities of the Crouse-Hinds' eleven field sales divisions. He will report directly to **E. R. Monesmith,** vice president-sales, and will make his headquarters in Syracuse.

Prior to joining the sales staff of Crouse-Hinds' Chicago division in 1942, Uhrlandt

Uhrlandt

Suppliers . . .

was associated with Westinghouse Electric Corp., Westinghouse Electric Supply Co., and the Niagara Mohawk Power Corp. In 1951 he was named manager of the Crouse-Hinds Buffalo region, and the following year was transferred to New York City as manager of the company's Northeast division, the position he has held to date.

Uhrlandt is a member of the International Association of Electrical Inspectors, the International Municipal Signal Association.

AMERICAN CYANAMID CO. has named **Howard E. Nehms** general sales manager of its Industrial Chemicals division, it was announced by **George W. Russell,** division manager.

The Industrial Chemicals Division's five departments market chemical intermediates, heavy chemicals and chemical specialties.

Nehms, formerly manager of the division's refinery chemicals department, joined Cyanamid in 1942 and has served in a variety of sales, technical and managerial posts. Prior to his experience with Cyanamid, he was associated with Allied Chemical and Dye. He attended Rutgers University and Columbia University and has served as an instructor at Bergen Jr. College.

Choose from the improved DH Line of Dean Hill horizontal turbines which give you up to twice the power of earlier models while maintaining the same economy of operation.

The major change contributing to this tremendous power increase is the addition of steam nozzles to all models. On types now built with two nozzles—DH-10, DH-15, DH-20, DH-25—this change has meant *a 100% increase in the maximum horsepower of each unit!* On new three-nozzle models—DH-30, DH-35, DH-40, DH-45—the rated increase in maximum horsepower is 50%!

Why not get the complete power picture of Dean Hill's improved DH Line of horizontal turbines? Write today for Turbine Catalog, No. 500.

DEAN HILL PUMP COMPANY
Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

OFFICES IN PRINCIPAL CITIES

WRIGHT INDUSTRIAL PRODUCTS has named **N. Gene Simpson** manager of its Houston office. Simpson is a graduate of Rice Institute where he earned his B.S. degree in mechanical engineering. He has had eleven years experience in sales engineering. Previously he was employed by Manning, Maxwell & Moore, Inc.

HARBISON-WALKER REFRACTORIES CO. has appointed **Harry S. Schweinsberg** assistant general sales manager. Sales manager of the company's Philadelphia district since 1948, he now will maintain headquarters at the home office in Pittsburgh. Mr. Schweinsberg has been with Harbison-Walker in various sales capacities since 1924.

TRETOLITE CO. has added **Wendell G. Markham** as a research chemist. For the past eleven years Markham has been associated with B. J. Service, Inc. in the capacity of chief chemist working in the fields of oil well cementing, production, stimulation, and corrosion.

Markham received his B.S. degree from Colorado State and his M.S. degree from Oklahoma A & M.

J. E. LONERGAN CO., Philadelphia, has appointed Stolley & Orlebeke, 605 W. Washington St., Chicago, as its representative in the Chicago territory.

Richard H. Stolley and **Howard P. Orlebeke** have a sound background in sales and application engineering in the fields which they well serve. A stock of popular size valves and gauges will be carried in the Chicago headquarters to offer prompt service.

JOHNS-MANVILLE CORP. has named **Adrain R. Fisher** chief executive officer in a realignment of executive responsibilities following retirement of **Leslie M. Cassidy,** chairman.

In accepting Cassidy's decision to retire because of ill health, the board of directors elected Fisher chairman. He also continues as president and director, offices he has held since 1951.

The board also created the new office of executive vice president. **Clinton B. Burnett** was elected to this post and was also made a director.

Fisher, who joined the Johns-Manville organization in August 1923, has served as a senior officer for 20 years.

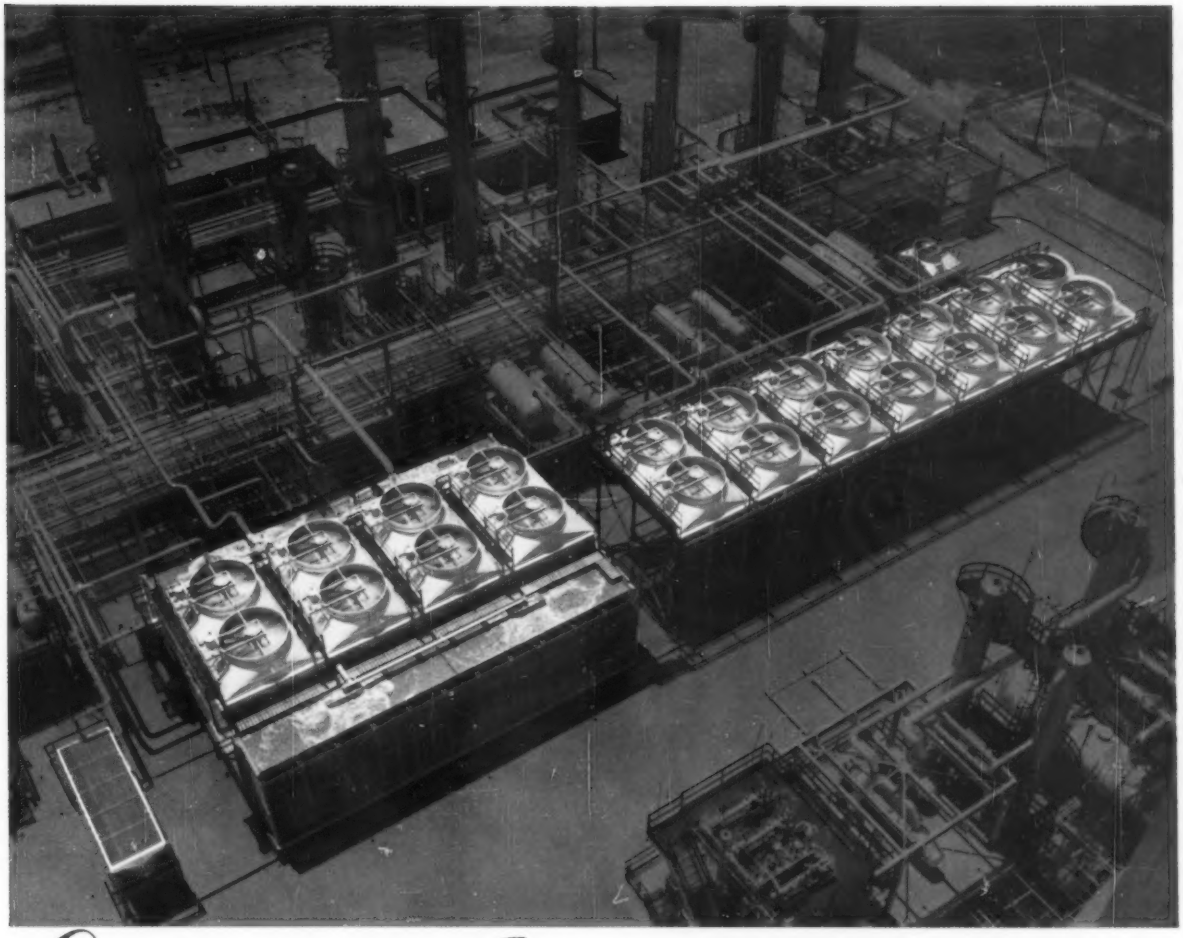
Burnett joined the Company in 1931, and for a quarter century gained wide company experience in production, engineering and administration.

DATAMATIC, a division of Minneapolis-Honeywell Regulator Co., has opened a Los Angeles office it was reported recently by **John E. Johnson** vice president of marketing, for the manufacture of large-scale electronic data-processing systems.

Samuel J. Weigand, recently named West Coast sales manager, will head the new office. Weigand, formerly assistant manager of the sales department, joined Datamatic in 1955 after working as production coordinator and systems and procedures analyst at the parent firm, Minneapolis-Honeywell. He is a graduate of the U. S. Naval Academy.

THE CUNO ENGINEERING CORP., Meriden, Conn., has elected **George K. Fraser,** Rear Admiral U.S.N. (ret.) as vice president in charge of engineering, research and development. In making the announcement, Murray McConnel, president of Cuno, stated that Admiral Fraser brings to the

For more data on advertised products, use Readers' Service Cards, last page.



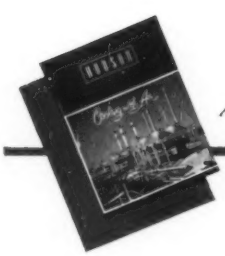
Cooling with Air AND MINIMUM WATER IN A MODERN REFINERY

Process cooling in Cosden Petroleum Corporation's new West Texas refining units is largely by direct use of air. Over 250 million BTU's per hour are dissipated directly to five billion standard cubic feet per day of air moved by 38 fans in HUDSON Solo-aire or Combin-aire units.

Solo-aire units are used where low effluent temperatures are unnecessary. Combin-aire units, in which air is first precooled with water, are used where lower effluent stream temperatures are required. The cooled water from the Combin-aires is available for other cooling services; the Combin-aires in this case performing the further function of water cooling towers. Water spray, carryover or condensation is impossible as the effluent hot air is under saturated with water vapor. Combin-aires are installed adjacent to other process equipment.

These Solo-aires and Combin-aires at Cosden, and hundreds of other HUDSON units in oil, gas and chemical processing plants confirm the advantages of cooling with maximum air and minimum water.

Before finalizing design of new process units, let HUDSON assist you in determining optimum balance in use of air and water.



Air-cooled equipment bulletin mailed upon request

HUDSON

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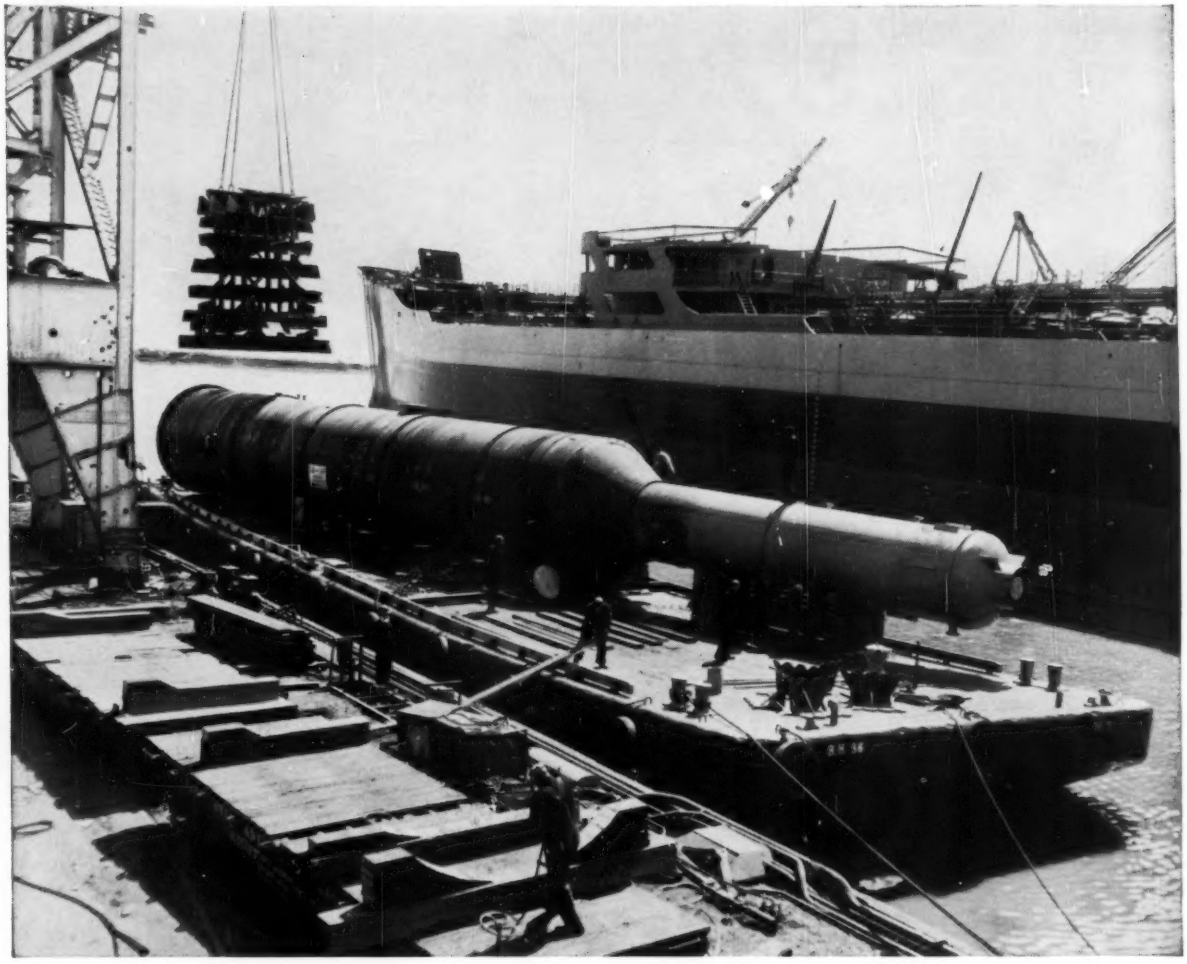
FAIRVIEW STATION • HOUSTON, TEXAS

OFFICES: 405 Lexington Ave., New York 17, New York • 2500 W. Sixth St., Los Angeles 57, California



standard procedure: VERSATILITY . . .

The variety of work which Sun Ship's integrated shops produce for use by industries on land and sea brings a matching variety of shipping problems.

Our facilities for tidewater shipment are used to economical advantage on many of the massive structures that go into the making of the nation's petroleum and chemical industries. The barge shipment of tower and shed row baffles, shown above, is a good example.

And of course—when shipment by land is necessary—Sun Ship rigging and routing find the ways and means to handle such items as large-diameter columns by rail and truck.

It's all a part of the versatility which forty years' experience has made part of "standard procedure" in service of its customers.

Our Sales Engineering Department would be glad to use its experience in helping you overcome any problem of construction or shipment that faces you. Write

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 **CHESTER, PA.**

Suppliers . . .

company experience gained from 30 years as a graduate engineer of the U. S. Navy.

Since his graduation from the U. S. Naval Academy in 1927, Admiral Fraser's career has been one of broad activity and high level responsibility. From June 1955 to January 1957, he administered a $1.5 billion procurement program for all types of naval ordnance equipment, services, research and development, and production. From January 1953 to May 1955 as Director, General Line School, Monterey, Calif., he headed one of the two schools composing the naval post-graduate school, a student body of over 500 naval officers engaged in the study of science courses.

Admiral Fraser was awarded the Legion of Merit by the Secretary of the Navy, for exceptional meritorious conduct during operations against enemy forces in Korea in 1952. He was further given a citation for exceptional meritorious performance of duty by the Bureau of Ordnance, U. S. Navy. His many service recognitions include the Air Medal and the Bronze Star Medal.

THE FLORI PIPE CO. and **Houston Pipe and Steel, Inc.**, as subsidiaries of the Sparton Corp., have announced a new national sales organization. This sales team now offers service on the spot for any type of piping fabrication service and information needed by the trade. District sales managers eliminate the need for dispatching a team from St. Louis or Houston as in the past.

HOOKER ELECTROCHEMICAL CO. has appointed **David S. Rosenberg,** manager of process improvement and development, heading a new group formed to study and improve existing Hooker chemical processes. The new group initially comprises eight chemical engineers transferred from operations and process study.

James E. Dillman was appointed technical supervisor, process study. He will supervise three men remaining in that group, of which he has been a member.

Dr. Elliott P. Doane was named supervisor, pilot plant, replacing Rosenberg and reporting to **Joy E. Beanblossom,** manager of development. Dr. Doane has been an engineer in the pilot plant.

Benjamin W. Hancock was appointed technical foreman of the area where Oldbury products are manufactured.

Mr. Rosenberg is a native of Cincinnati, Ohio, where he received a B.S. degree in chemical engineering from the Engineering and Commerce School of the University of Cincinnati in 1939. He immediately joined Hooker as a chemical engineering investigator, becoming a group leader in 1942. In 1956 he was named pilot plant supervisor.

FLORI-HOUSTON PIPE FABRICATION DIVISION of the Sparton Corp., has appointed **A. C. Armendariz** sales representative. He will use Mexico City as a base for opera-

Send for your **FREE** copy of the **New Petroleum Books Catalog** containing descriptions of many books pertaining to the Petroleum Industry. Send your request to **Book Department, Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.**

MODEL "M" SERIES

Marksman tubeless electronic potentiometer strip chart RECORDER for recording and controlling such variables as temperature, speed, strain, pH and many others.

- No vacuum tubes. Sensitivity of 5 micro-volts or less.
- Potentiometer for thermocouple (TCB protected) or radiation pickup, Wheatstone bridge for resistance pickup.
- Full selection of standard scale ranges . . . 11" calibrated chart width.
- Selector knob changes chart speed . . . 5 speeds per unit without gear change.
- Single or multi-record units available.
- Equipped for 115 or 230 volts — no transformers needed.
- Additional features: Automatic standardization . . . cold junction compensation for thermocouple use . . . battery condition indicator for potentiometer . . . built-in chart saver . . . designed for standard 19" relay rack.

WEST *Instrument* **CORPORATION**
SALES OFFICES IN PRINCIPAL CITIES
4337B W. MONTROSE, CHICAGO 41, ILL.
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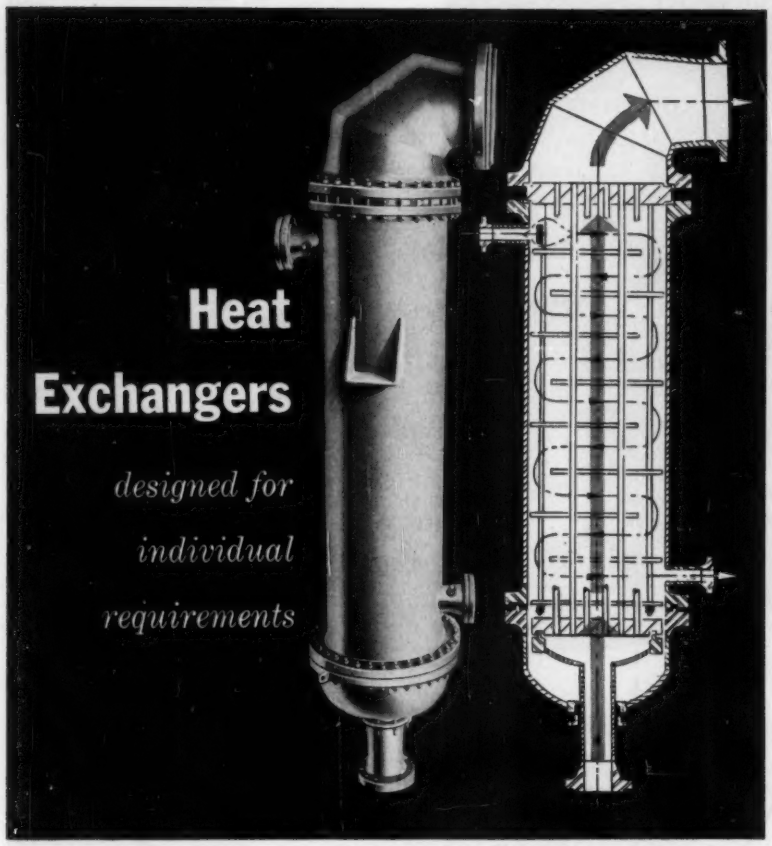
NOW you can have all these practical advantages in a single instrument. Write for Bulletin M.

the trend is to **WEST**

For more data on advertised products, use Readers' Service Cards, last page.



Vertical thermosyphon type reboiler.

Forty years experience designing and fabricating equipment to withstand extreme conditions of temperature, pressure and corrosion ... fine facilities ... personal follow-through to meet customers' exact requirements ... all combine to make SWECO *the* dependable source for heat exchangers.

SWECO Heat Exchangers are manufactured from SWECO designs developed to meet the needs of individual clients, or from designs provided by the client. There are several standard types, all of which can be adapted to meet special requirements. Depending on the needs of the installation, they can be fabricated from any of a wide range of materials, including stainless steels, quality carbon steel plate, low alloys, Monel, Inconel, aluminum, copper and brass. Proper allowance for fouling factors assures dependable long-term operation without costly down-time for cleaning and repairs.

As an additional service, SWECO has facilities for rebuilding, replacing and repairing all types of tubular heat exchange equipment. Materials for replacement components held in open stock provide extra-fast service during shut-down periods.

For detailed descriptions and illustrations of SWECO Heat Exchangers, and Pressure Vessels, write for bulletin M-8-333.

See SWECO *equipment at the 26th Exposition of Chemical Industries, New York Coliseum, December 2-6, Booth 1250.*

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Engineers and Constructors ... Manufacturers

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tions and be available for personal calls anywhere in Mexico.

This new sales set-up is significant as the Houston fabricating plant has the Port of Houston for fast shipment to Mexico and South America.

Educated in the United States, and a graduate of Purdue University, Armendariz has offices at Apartado Postal 80 BiS, Mexico, D. F.

JONES & LAUGHLIN SUPPLY DIVISION'S **W. L. Wolfe**, vice president-sales, has announced six personnel changes within the firm's field sales division.

E. J. Pierson, formerly a resident salesman at Perryton, Texas, has been transferred to Liberal, Kans., to serve as salesman. **G. N. Brotherton** has been made resident salesman at Bunkie, La. He formerly was local store manager there. **S. J. Payne**, salesman, has been moved from Borger, Texas, to Liberal, Kan. **W. M. Wilkinson, Jr.** has been promoted from storeman at Corpus Christi, Tex., to salesman at Freer, Texas. **H. B. Ham** has been transferred from Oklahoma City, to serve as salesman at J&L's Odessa, Texas store. **R. M. Sutter**, salesman, has been transferred from Odessa, to Oklahoma City.

It was also announced that **James M. King** has been appointed salesman at Blanding, Utah.

King joined Jones & Laughlin as storeman at Newcastle, Wyo., in October of 1954. He was transferred to Sterling, Colo., in March, 1955 as storeman and held that position until his present appointment.

UNITED STATES STEEL CORP. has appointed **Donald L. Marsh** district engineer at Midland, Texas for its Oil Well Supply division it was announced by **William Miskimins**, central midwest area manager of the division.

Marsh was employed by "Oilwell" in 1949 at Odessa, Texas. Later that year he was appointed assistant district engineer at Tulsa, and in February, 1950, was named field engineer at Snyder, Texas. He was appointed assistant district engineer at Odessa in 1950 and in 1951 was transferred to Shreveport, La. In 1952 he was appointed district engineer at Odessa and was transferred to Midland, Texas, in 1955.

He received a B.S. degree in engineering from Purdue University, Lafayette, Ind.

TRACERLAB INC. has received a contract for classified research and development work from the Air Materiel Command for $1,285,000 covering research and other services to be performed at Tracerlab.

OLIN MATHIESON CHEMICAL CORP. has announced that **George A. Waterman** has joined the company as director of product sales and engineering for Olin Aluminum. **Sam Gurley, Jr.**, vice president of sales, Aluminum division, made the announcement. He had been manager, extrusion sales, for Kaiser Aluminum and Chemical Sales Inc., Chicago.

Waterman will have direct responsibility for the direction and coordination of product and industrial sales, and engineering service.

Prior to his Kaiser affiliation Waterman served in various technical and sales capacities wth Revere Copper and Brass, Inc. His last position with Revere was that of assistant sales manager for alumi-

HERE ARE THE TEST PHOTOS:

This is a Rockwood Spot Protection System discharging FogFOAM at a pipeline pumping station. Fire could break a link in the pumping system which could interrupt or stop refinery production. The Rockwood System goes off automatically by a rate-of-rise detection system and protects against such an eventuality.

Here's the same scene from another angle after only 3 minutes of the Rockwood Protection System operation! There's a four inch blanket of Rockwood FogFOAM on the floor — and there's no longer any danger of flashfires starting.

Rockwood FOAM delivers four inches of fire protection *in three minutes!*

Rockwood FogFOAM systems *instantly and automatically* discharge FogFOAM to the fire area where it forms a fast flowing heavy blanket of FOAM. Within seconds of the fire's start Rockwood FOAM literally covers the fire and strangles it. Flashbacks are prevented.

Write for full information on how your plant can be spot protected against costly flammable liquid fires by Rockwood precision engineered fire-fighting equipment. Send for your booklet now —

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

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Please send me your illustrated booklet on Spot Protection Systems.

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For more data on advertised products, use Readers' Service Cards, last page.

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Suppliers . . .

num in the company's Midwestern division. Previously, he spent more than five years in the company's New England division as assistant sales manager for copper and brass, and as technical advisor to the division.

Waterman attended the University of Michigan and Illinois Institute of Technology, majoring in metallurgy, and received an M.S. degree in business administration from the University of Chicago.

BABCOCK & WILCOX CO. has announced that its Tubular Products division plans to expand and modernize its alloy and stainless steel making facilities with the addition of a new electric arc furnace and associated equipment. This was reported by **Edward A. Livingstone**, vice president in charge of the division.

The new facilities will be located near an existing extruded shapes fabrication building owned by the company, in the Koppel, Pa., area approximately four miles from the main Tubular Products division plant in Beaver Falls, Pa. Livingtone estimated that the facilities would cost between $12 million and $14 million.

Completion of the new facility has been scheduled for late 1959, Livingstone said.

TRETOLITE CO. has announced that **Bobby G. Little**, field engineer at McCamey, Texas, has been transferred to Cortez, Colo., as representative in the four-corners area. He has been replaced at McCamey by **Howard McWhorter** who joined Tretolite this year after graduating from Southern State College, Magnolia, Ark., where he studied chemistry.

THE BROWN INSTRUMENTS DIVISION of Minneapolis-Honeywell, Philadelphia, was awarded the 1956 Public Relations News' annual "Achievement Award" for "its pioneering campaign to allay fears of automation by giving business . . . the true facts about the economic and social benefits . . ." M-H was one of ten firms and organizations to receive the publication's 1956 award, highest recognition in the field of public relations.

The manufacturer of automatic controls,

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Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

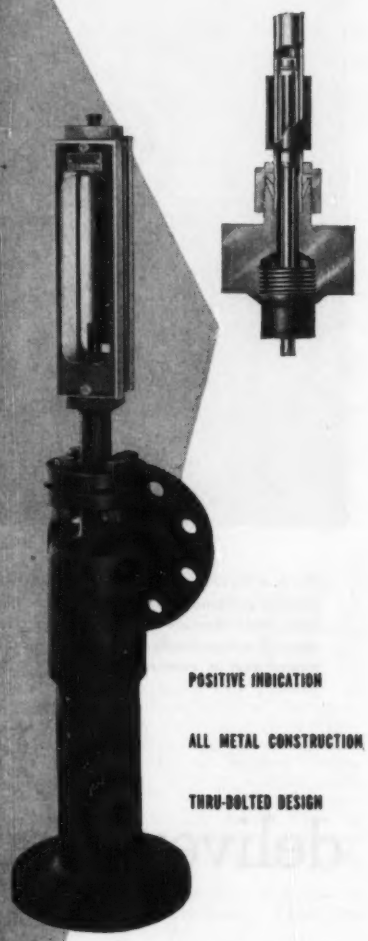
QUICK! ECONOMICAL! RESULTFUL!

Help Wanted! Classified Ads in Petroleum REFINER get the job done.

BROOKS LEADERSHIP
achieved by design

AR-MET ROTAMETER

. . . takes practically *all* fluids off the hard-to-handle list



POSITIVE INDICATION

ALL METAL CONSTRUCTION

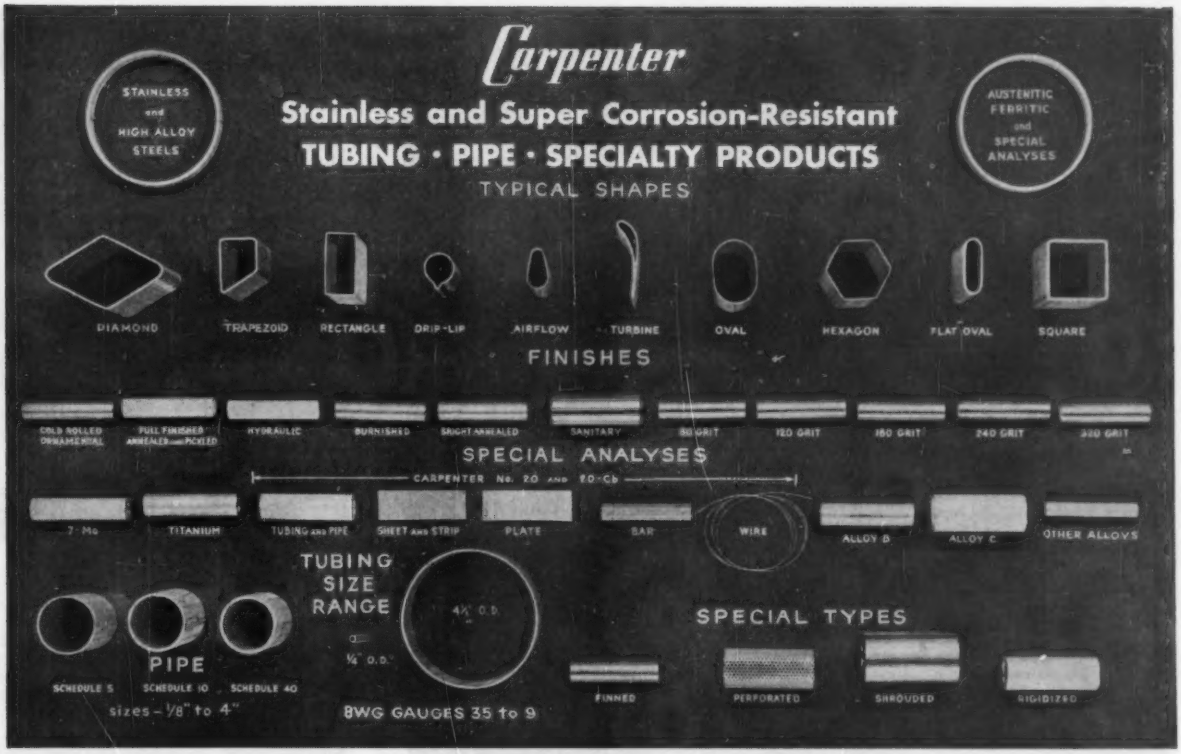
THRU-BOLTED DESIGN

Working with highly penetrable fluids . . . high temperatures, high pressures? Then, Brooks Ar-Met Rotameters are made to order for you.

The Brooks Ar-Met Rotameter with Mag/Na/Vue indicating extension is shown . . . however, Ar-Met meters are also available with six other alarm and transmission extensions, both electrical and pneumatic. WRITE FOR BULLETIN 130

BROOKS ROTAMETER COMPANY
1257 Q STREET LANSDALE, PENNSYLVANIA

A complete line . . .
BROOKS ROTAMETERS
. . . for every service



Experienced hands at solving many corrosion and heat problems

Your choice of over 35 analyses for
• corrosion resistance • heat resistance
• light-weight strength

AISI TYPES			SUPER CORROSION-RESISTANT TYPES
302	310	321	
304	316	347	Carpenter Stainless No. 20Cb
304L	316Cb	348	Carpenter 7Mo
309	316L	430	Carpenter Alloy B
309S	317	442	Carpenter Alloy C
309SCb	317L	443	Titanium 55 and 70

Other specialty grades in various stages of development are available: Zirconium, Zircalloy II, 19-9 DL, Invar, HiMu80, N-155, Haynes No. 25 (L-605), Hastelloy F and Hastelloy X, Armco 17-7PH, Titanium alloys, A-286 and others.

Here's why it will pay you to consult Carpenter about corrosion and heat-resistant tubing for pressure, mechanical, structural and sanitary requirements: The wide variety of types, grades, shapes, finishes and sizes illustrated can be supplied in the many standard and speciality analyses listed above. You benefit from over a quarter century of experience in helping equipment designers and builders solve a vast assortment of corrosion and heat problems. Carpenter's meticulous quality control assures you of getting tubing and pipe of the highest possible degree of perfection. Technical and metallurgical assistance with your materials selection and fabrication and nation-wide service on your requirements are available through qualified Carpenter Distributors and Representatives in over 40 cities.

Put your problems in Carpenter's capable hands today. Ask for Bulletin T.D. 120.

MEMBER STEEL FOUNDERS' SOCIETY OF AMERICA

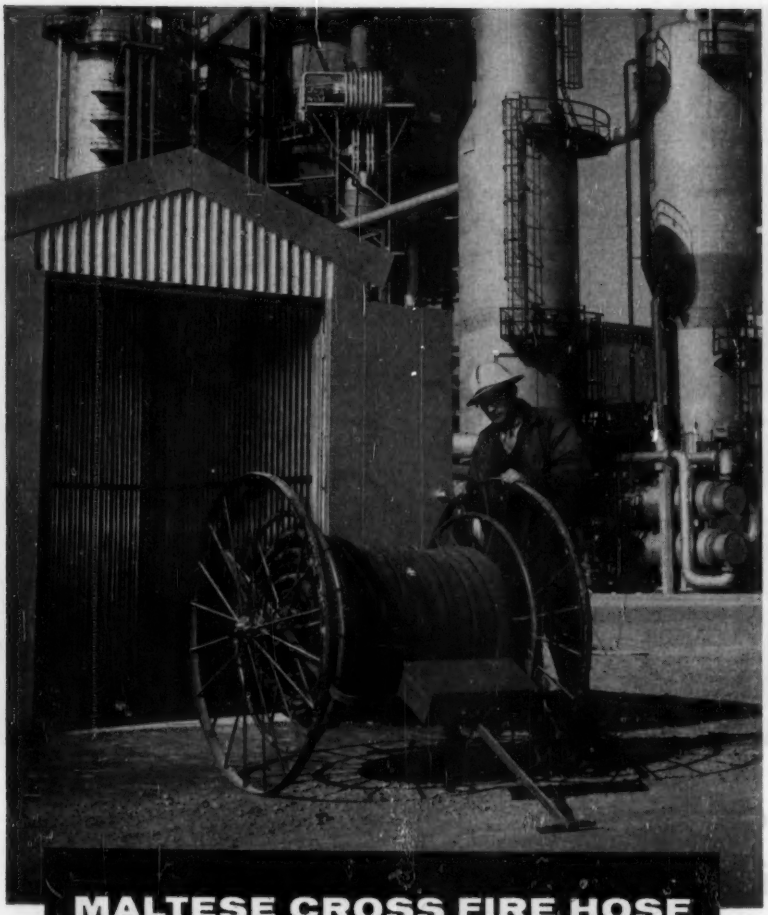
The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

For more data on advertised products, use Readers' Service Cards, last page.



MALTESE CROSS FIRE HOSE
GIVES GREATER SAFETY,
LASTS FIVE TIMES LONGER

Because it lasts five times longer than ordinary fire hose, Maltese Cross proved the most economical choice for the Tidewater Oil Company refinery near Wilmington, Delaware. It averages fifteen to twenty years' life in refinery service. Other benefits for Tidewater are Maltese Cross' 10 to 35 times greater fire resistance, and easier, safer handling for firemen.

The hose is placed on reels located at strategic points and is also carried on the refinery's fire trucks. Its neoprene cover makes it resistant to petroleum, mildew, and rot; and it is so constructed that it will not swing, writhe, twist, elongate, or contract under pressure. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

HR HEWITT-ROBINS

CONVEYOR BELTING AND IDLERS . . . POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE . . . VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

Suppliers . . .

largely through its Brown Instruments division, has taken every opportunity to separate fact from the fanciful assumptions enshrouding automation. Since 1952 company and divisional executives, led by Brown president **Henry F. Dever**, two-time head of the Scientific Apparatus Makers Association, have discussed the subject before national and regional groups.

Johnson

Cox

MANNING, MAXWELL & MOORE, INC., has named **Arthur W. Johnson** manager of Ashcroft Gauge products, and **Jack E. Cox,** manager of Consolidated Safety Valves, **William H. Bolin,** manager of product planning, Consolidated Ashcroft Hancock division, M.M.&M. announced recently.

Johnson is a graduate of Rensselaer Polytechnical Institute, and worked in the metallurgical department of Bethlehem Steel Corp. prior to joining Manning, Maxwell & Moore in 1943. Starting as assistant metallurgist with the Stratford company, he advanced to development engineer before leaving to serve with the Navy.

Rejoining M. M. & M., he was appointed sales engineer in Pittsburgh and was later transferred to New York in the same capacity. In 1956 he was made product manager, Consolidated Safety Valves.

Cox, who succeeds Johnson, was recently sales engineer in New York. After attending the University of Cincinnati, majoring in mechanical engineering, he served in the Air Corps in World War II. Joining Manning, Maxwell & Moore in 1948 as sales engineer, he was transferred to the New York area in 1955.

THE YOUNGSTOWN SHEET AND TUBE CO. has begun the scheduled operation of its new seamless pipe mill at the Indiana Harbor works, East Chicago, Ind., according to **Harold Hoekelman,** Chicago district manager.

With this unit for the making of seamless line pipe and oil country tubular goods now operating, The Youngstown Sheet and Tube Co. will swing into a new phase of production at its expanding Indiana Harbor Works, Mr. Hoekelman said.

FAIRBANKS, MORSE & CO., Chicago, announced that **Page S. Procter,** who has for many years been manager of the company's New Orleans branch, is retiring January 1, 1958.

W. F. Wahlenmaier, who has for the past few years been manager of the company's Portland branch, is taking over the post vacated by Procter.

Milo C. Roy, who has been with the company many years, being Branch manager at St. Paul, Omaha, and for the past

We're taming some of the country's biggest "CATS"

Perhaps we are guilty of some slight exaggeration when we use the word "taming." What we really mean is that SMITH Forged Steel Small Utility Valves are being used today in ever-increasing quantities by a large portion of the major refineries, chemical and petro-chemical plants in this country and Canada.

We maintain that the continuous flow of day-to-day repeat orders from these companies is conclusive evidence that SMITH Valves can "take it" . . . that they have met the challenge of ever-increasing temperatures, pressures and corrosion . . . that they are giving longer, trouble-free life in service.

Write today for our new catalog giving complete information on our entire valve line.

NEW ENGLAND VALVE Corporation

P. O. BOX 1047 • WORCESTER, MASSACHUSETTS

West Coast Distributors: BETHLEHEM SUPPLY CO., LOS ANGELES, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

eight years of the Chicago sales and service branch, is being transferred to the Portland branch succeeding Wahlenmaier.

W. B. Morse, who has been with the company many years in a number of positions, more recently assistant to the manager of the Chicago branch, has been promoted to manager of that branch.

Edward E. Lynn has been named director of personnel of the company succeeding **L. R. Gaiennie** who recently resigned. Lynn was a partner in the law firm of Thompson, Raymond, Mayer, Jenner & Bloomstein which has served as counsel to Fairbanks, Morse & Co. for over a quarter of a century.

THE BABCOCK & WILCOX CO. announced it will furnish the boiler and related generating equipment at the Research & Development center being built by Thompson Products, Inc.

Located on a 1050 acre site approximately 20 miles south of Roanoke, Va., the Center will use the steam generated by the B&W equipment exclusively for conducting research projects, including the testing of components for missile system experiments with monopropellant and bipropellant fuels. To simulate conditions at actual operational altitudes of the missile, steam supplied by the B&W boiler will be used to operate the steam ejectors which exhaust both the turbine discharge and the experimental test chamber. The steam will also be used as a heat source for preliminary heating to temperatures of 300 F.

THE TUBE TURNS DIVISION of National Cylinder Gas Co. will increase its manufacturing area approximately 40 percent by converting buildings on property adjacent to its main plant.

The company announced the signing of a $400,000 construction contract with Sullivan & Cozart to connect three existing buildings, creating a new manufacturing area under one roof.

John G. Seiler, Tube Turns' president, said the construction program would provide plant facilities for products now in the design and development stage and for expansion of the welding fittings and custom forgings departments.

The new construction will take place on a 13 acre site purchased in July 1956. Besides the three buildings that will be connected, there is a fourth existing building on the property that provides additional floor space for the expansion program. An adjacent 2.6 acre plot, also purchased recently, is available for future construction.

KIRK COUSART AND ASSOCIATES, manufacturers representatives with Home Offices in Charlotte, N. C., have opened an office in Greensboro, N. C. **W. S. Mitchell** has been named manager of the new office which will be located in the Waynick Building, 1882 Pembroke Road. He formerly was manager of the firm's Durham, N. C., office.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has appointed **E. J. Byrne** petroleum industry manager for the Industrial division announced **J. A. Robinson,** field sales manager.

Byrne joined Honeywell in 1947 as an industrial instruments salesman in Houston. He subsequently was industrial sales manager in Dallas and for the last four years served in the same capacity at Houston.

Robinson also announced that **K. R. Knoblauch,** who became associated with Honeywell in 1924, will devote full time to duties as chemical industry manager on a national basis. Knoblauch formerly was metals processing industry manager.

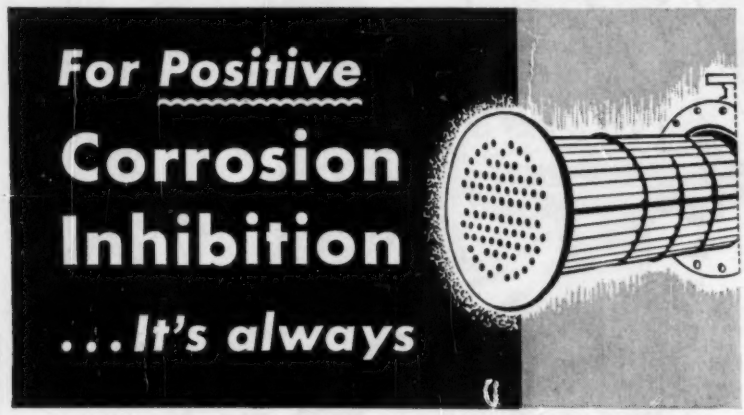
Two new industrial managers have been named for the Dallas and Houston offices. At Dallas, **Paul R. Sharadin** succeeds **Robert Harris,** who becomes district manager at Tulsa. **C. D. Walker** succeeds Byrne at Houston. Walker joined Honeywell in 1948, Sharadin in 1951.

OLIN MATHIESON CHEMICAL CORP. has appointed **Laurence E. Russell** director of marketing for the organic chemicals division, it was announced by **Russell Hopkinson,** executive vice president.

Russell will be responsible for sales, advertising and sales promotion and sales development. He had been manager of the sales development department in the industrial chemicals division.

Hopkinson also announced three other appointments to the marketing department:

Reid Malcolm, sales manager; **B. N.**



WRIGHT PENECHROMES
(Zinc Chromate Organics)

- ✓ Proved in Cooling Systems for over 11 years
- ✓ Safe pH Ranges*
- ✓ No Sludge Precipitate
- ✓ High Temperature Tolerance

**Cooling Tower Institute Bulletin WMS-104*
Wood Maintenance for Water-Cooling Towers

Through many years of experience Wright Engineering has developed Wright Penechromes as an effective answer to corrosion . . . if you have a common or "special" problem, write for an engineering survey of your water using equipment. A comprehensive conditioning program by Wright will pay big dividends.

Write us on your company letterhead for the new Wright Cooling Water Calculator—it quickly calculates operational data.

WRIGHT CHEMICAL CORPORATION
GENERAL OFFICES AND LABORATORY
619 WEST LAKE STREET, CHICAGO 6, ILLINOIS
Offices in Principal Cities

- Softeners, Filters and other external Treating Equipment
- Nelson Chemical Proportioning Pumps

Wright CHEMICALS

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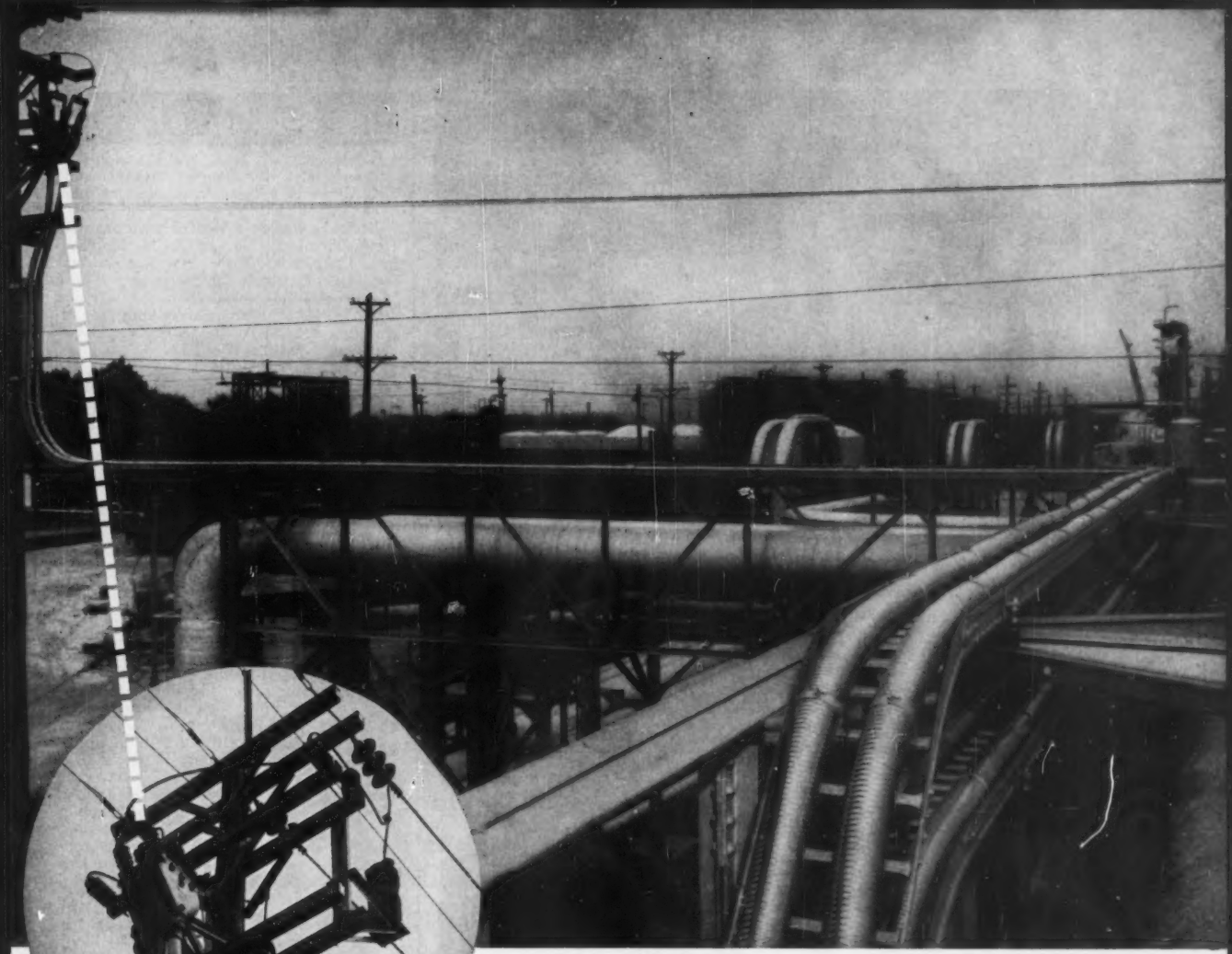
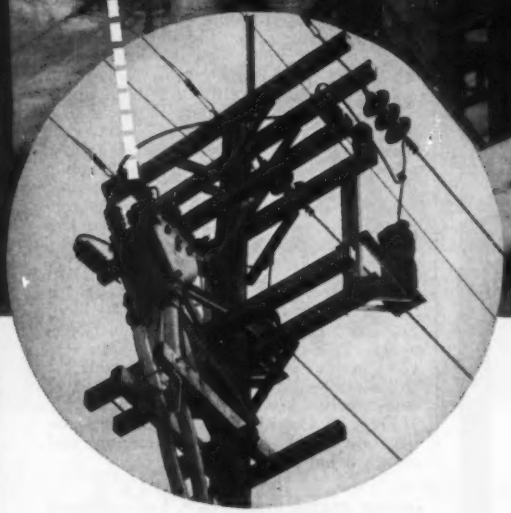
Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings. Use Readers' Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.





new 15kv Loxarmor* circuits eliminate conduit, allow simple terminations

Stainless steel Loxarmor cable was recently chosen by the Petro-Tex Chemical Corporation, jointly owned by Tennessee Gas Transmission Co. and Food Machinery and Chemical Corp., for main feeder circuits in their Houston, Texas plant.

Heart of this system is Okolite insulation applied by Okonite's strip-insulating method. The advantages inherent in the Loxarmor construction add considerably to the basic advantages of the Okolite insulation.

Advantages of Loxarmor construction:

... stainless steel armor provides the ultimate resistance to corrosive atmospheres prevalent in petrochemical plants.

... reduces installation and maintenance costs because of flexibility and the elimination of rigid conduit. Open type construction permits quick, simple inspection of your electrical system.

... completely salvageable—can be reused at will or can be easily re-routed.

... standard fittings permit relatively simple terminating procedures.

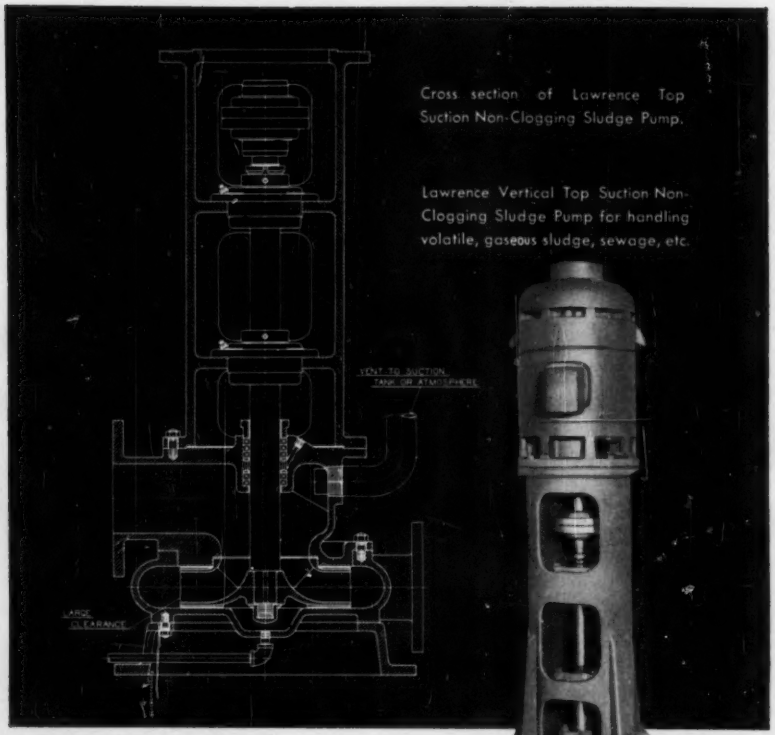
Petro-Tex Chemical Corporation's use of this construction typifies the modern trend to Loxarmor. Where the maximum security of a rigid conduit is not necessary, Loxarmor is a highly acceptable alternate.

Bulletin PR-1090 provides a thorough description of Loxarmor, providing engineering information, splicing and terminating drawings and instructions, and a discussion of the various components. Loxarmor power and control cables are available with any of Okonite's strip-insulated and extruded rubber insulations or with varnished cambric and plastic dielectrics. Write for it today to The Okonite Company, Passaic, N. J.

***Okonite's trade name for interlocked S-shaped armor—available in stainless or galvanized steel, aluminum or bronze. Protective coverings can be applied over the armor for special corrosion and chemical resistance.**

4710

where there's electrical power... there's **OKONITE CABLE**


Cross section of Lawrence Top Suction Non-Clogging Sludge Pump.
Lawrence Vertical Top Suction Non-Clogging Sludge Pump for handling volatile, gaseous sludge, sewage, etc.
VENT TO SUCTION TANK OR ATMOSPHERE
LARGE CLEARANCE

PUMP *volatile* SLUDGES AND SLURRIES

...without clogging
...under a low net positive suction head (NPSH)
...without gas or vapor binding

The Lawrence Non-Clogging Top Suction Pump is designed specifically to handle volatile sludges and slurries. Large clearances through the impeller and casing completely prevent clogging. Volatile gases or vapors liberated at the impeller entrance (the point of lowest pressure), are pushed up and out of the way and can be vented back to the suction tank or exhausted to atmosphere.

This type of pump can operate with a very low Net Positive Suction Head (NPSH) and never become gas or vapor bound. It is made in all metals and alloys such as: — cast iron, bronze, stainless steel, Hasteloy, etc. — depending on the material pumped.

For further details on Lawrence Non-Clogging Slurry and Sludge Pumps write for Bulletin 206-4.

LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

Suppliers . . .

Schrauf, sales development manager, and **Dr. Albert H. Gower,** product sales manager.

Malcolm had held various positions with Dow Chemical Co. and R. N. Hollingshead Corp. Schrauf formerly was assistant manager of market development for Olin Mathieson's industrial chemicals division and Dr. Gower has held various administrative posts at American Cyanamid Co. and Sun Chemical Corp.

UNITED STATES STEEL CORP. has appointed **Walter S. Palmer** as area merchandise manager at Calgary, Alberta, Canada, for the Oil Well Supply Division of U. S. Steel.

Palmer was employed in 1947 by the division at Okotoks, Alta., and in 1949 was appointed store manager at this location. In 1953 he was transferred to Edmonton as store manager and in 1956 was named assistant to district manager at Edmonton, holding this position prior to his present appointment.

FISCHER & PORTER CO. has moved into its new office building adjoining its Hatboro, Pa., plant. The latest techniques were used in erecting the two-story structure, among them the "lift-slab" method by which concrete floors and roof are cast on the ground and then raised into position by hydraulic jacks. Three stained glass panels of abstract design relieve the monotony of the windowless walls. An exception to the windowless construction is the cafeteria which has floor-to-ceiling windows overlooking an outdoor roof patio. The cafeteria has a stage and is easily converted into an auditorium.

THE FLUOR CORP. OF CANADA, LTD., has moved its headquarters from 200 Bloor St., East, Toronto, Ontario, to the Continental Life Building at 160 Bloor St., East, in that city. In its new quarters the engineering-construction firm will have more space.

Fluor of Canada does engineering-construction work for the petroleum and chemical industries.

UNITED STATES STEEL CORP. has appointed **William W. Crawford** director of purchases. This was announced recently by **Ralph C. Moffitt,** newly-appointed vice president-purchases.

Associated with U. S. Steel since 1946, Crawford succeeds Moffitt as director of purchases, advancing to this position from assistant director of purchases.

Crawford joined the corporation as practice apprentice in the metallurgical department. In 1947, he was named a

Free to PETROLEUM REFINER Subscribers

Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings.

Use Reader's Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

For more data on advertised products, use Readers' Service Cards, last page.

Today at Westinghouse— men like these are engineering new dependability for process automation

Developments in motor design and insulation . . . static control systems and power rectifiers show how Westinghouse engineering and research provide new dependability for confident expansion of automatic operation. Engineering is constantly probing, exploring and identifying the practical. Thus improving present products with better protection and longer life. You profit from minimum process interruption, reduced maintenance costs and new opportunity to expand safely.

Motor problems in chemical and petroleum processing dictated the design and improved materials for the Life-Line® "A" totally enclosed motor. Since insulation is a major factor determining process motor life, Westinghouse introduced Bondite* stator insulation. Bondite is a silicone-reinforced thermosetting varnish that has outstanding resistance to *both* corrosive liquids and vapors. Some stator insulations can be dipped into water with no adverse effect, but have low resistance to vapor. Bondite seals out both, whether water, oil or chemical.

In addition, Westinghouse Bondar* conductor insulation has a life expectancy of more than three times that of conventional conductor insulations. It improves resistance to heat, provides greater dielectric strength and greater resistance to moisture, oils, dust and dirt.

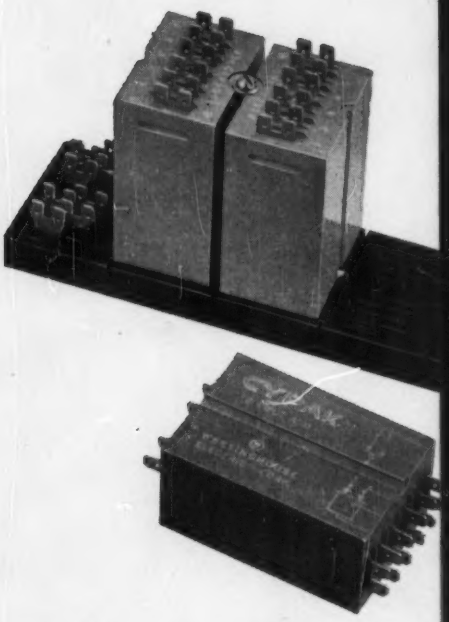
(*Continued on next page*)

MP-3053-1

*Trade-Mark

YOU CAN BE **SURE**... IF IT'S Westinghouse

Here's proof of new dependability to advance automation



Cypak static control and power bus

Cypak outlasts conventional control 15 times. Cypak* is the first static industrial control system with no moving parts to wear, corrode or jam. It is a revolutionary means of providing automatic electrical control for processing operations and co-ordinated materials handling. The Cypak memory operation is also designed for complete plant alarm systems.

Westinghouse Silicon Rectifiers are static devices which have been developed for use in the 300-volt class and below. Air-cooled Silicon Rectifier assemblies withstand extremely high temperatures and have an efficiency equal to or better than other conversion equipment.

Thermalastic, the insulation with a memory, remembers to expand and contract with the coil. This prevents tape separation, the major cause of insulation failure. Thermalastic® Insulation ignores water, chemicals, dirt and other contaminants. Over 40-million hp are protected by Thermalastic Insulation throughout industry today.

Large motor drive demonstrates 30% better protection.

Thermalastic-insulated coils have proved a dielectric strength 30% higher than conventional types. In the picture at the right, water is sprayed into the air inlet opening while this 600-hp, 4160-volt squirrel-cage motor is running at normal speed. Immediately following the spraying, the coils successfully withstood three times the normal line-to-ground voltage.

Ten years ago, this picture could not have been taken. Thermalastic Insulation is the result of nine years' research and engineering and several million dollars' investment by Westinghouse.

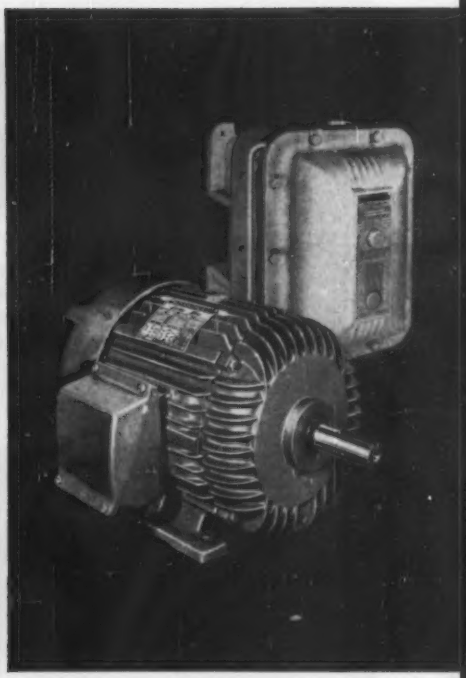
Investigate all the many Westinghouse developments for drive dependability by calling your local Westinghouse salesman; or write, Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. MP-3053-2

*Trade-Mark

YOU CAN BE SURE...IF IT'S Westinghouse

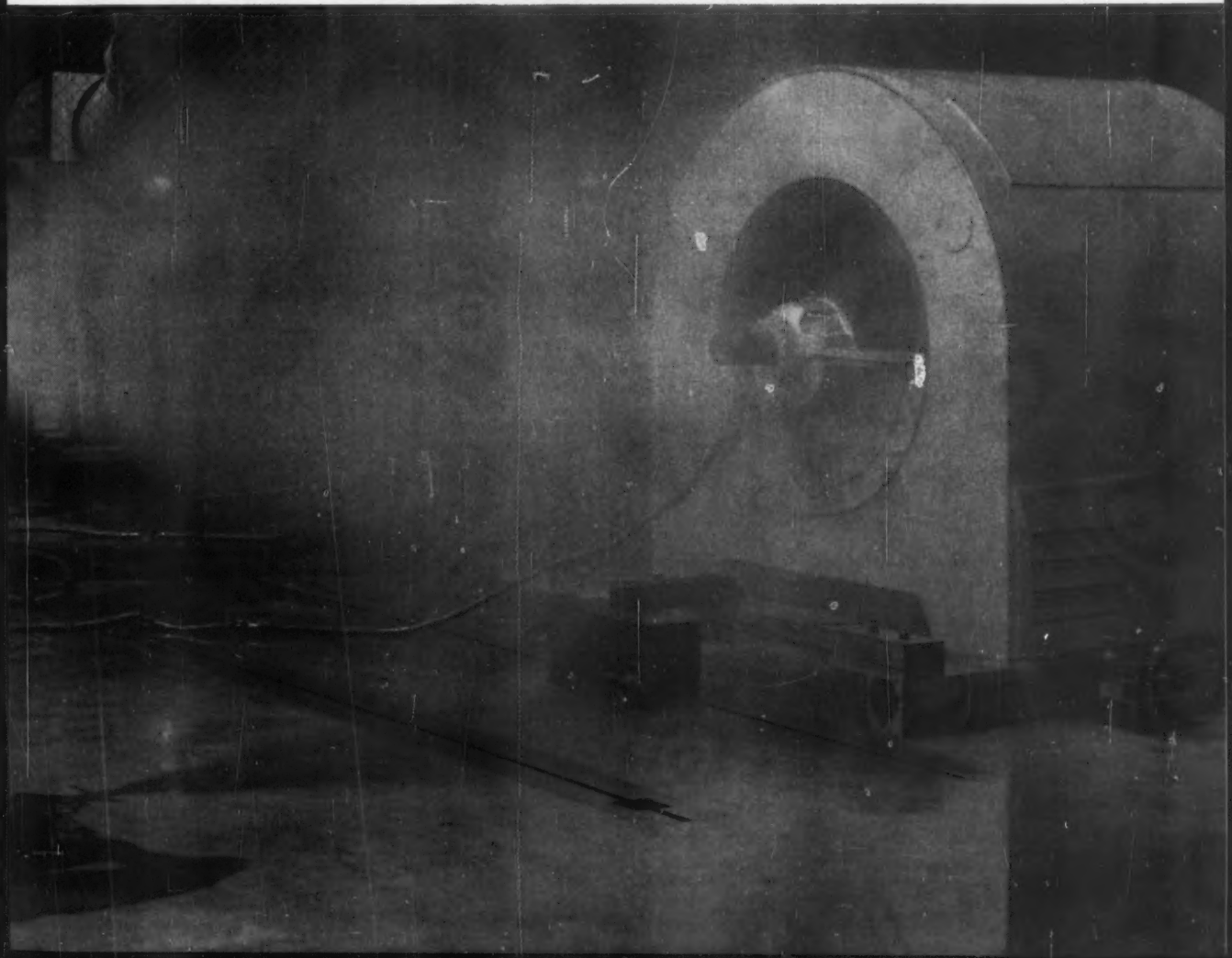
Westinghouse Silicon Rectifier

Applying Thermalastic Insulation



Life-Line "A" Motor and explosion-proof Life-Line Starter

MP-3053-3



STOPPLE APPLICATION
HOT TAPPING
PIGGING
BUSHINGS & INSULATORS

Agent for T. D. Williamson, Inc.

MARKER VENTS
AERIAL MARKERS
WELL MARKERS
SAFETY SIGNS

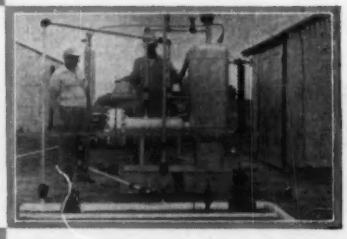
Sole Distributors for L & M Co.

ASPHALT OUTERWRAP
ASPHALT COATING
ROCK SHIELD

Agent for Gulf States Asphalt Co.

H & H GAS ODORIZERS
Built to your specifications

Manufactured by Tod Pazdral



GUILLOTINE SAWS
NATIONAL SAWS

Agent for E. H. Wachs Co.

MERCURY HYDRAULIC
PIPE PUSHERS

Tell 'Em
We'll Be There!

You can depend on Topaz sales engineers to be on the job--on time--working in cooperation with your engineering department. Topaz service includes furnishing all equipment on a lease, contract or purchase basis. Call Topaz day or night . . . we'll be there!

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PIPELINE SPECIALTIES
2525 South Boulevard • Houston 6, Texas
Day Phone JA 2-1403 • Night Phone MA 3-5680

Suppliers . . .

buyer in the electrical group, and in May, 1951, was advanced to assistant purchasing agent for electrical and mechanical equipment. Promotion to purchasing agent in the same field followed in 1953, and on October 1, 1955, Crawford was elevated to the position he held until his present appointment.

Crawford graduated from Princeton in 1943 and from the Carnegie Institute of Technology program for executives in 1956.

BLAW-KNOX CO., Pittsburgh, has established a Central Traffic department according to an announcement by **J. E. McWilliams**, vice president-purchasing.

Morgan

Dudley E. Morgan, who joined the company in 1955 as traffic consultant, was named general traffic manager of the new department. **Bert F. Siverts** was apponted assistant general traffic manager. The company's present divisional traffic organizations will be maintained, with **W. W. Larkin** continuing as traffic manager at Wheeling and Warwood works, **A. Z. Randall** as traffic manager at the East Chicago (Ind.), plant, and **M. A. Ludig** at the Blaw-Knox Equipment division. The Central Traffic department will supervise traffic directly for all other divisions of the company, as well as advising and assisting all division traffic managers.

Morgan was formerly associated for 30 years with the Follansbee Steel Corp. as general traffic manager.

Siverts joined Blaw-Knox in 1953 and has served the company in various transportation capacities, including assignments at the Hanford, Washington, AEC site.

TRETOLITE CO. has added **James S. Martin** as field engineer at Hobbs, N. M. He will replace **Kenneth Little** who is being trans-

Be Sure To Check This Month's Classified Section in REFINER

Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

QUICK! ECONOMICAL! RESULTFUL!

Help Wanted! Classified Ads in Petroleum REFINER get the job done.

For more data on advertised products, use Readers' Service Cards, last page.

Remarkable resistance to heat and harsh chemicals

PROPERTIES OF "ARMALON" FELTS

GENERAL

Highly resistant to strong acids and bases at all temperatures.

Unaffected by water, common fuels, lubricants, hydraulic fluids, solvents.

High anti-stick properties.

Low coefficient of friction.

For FILTERING MATERIALS—tetrafluoroethylene felts

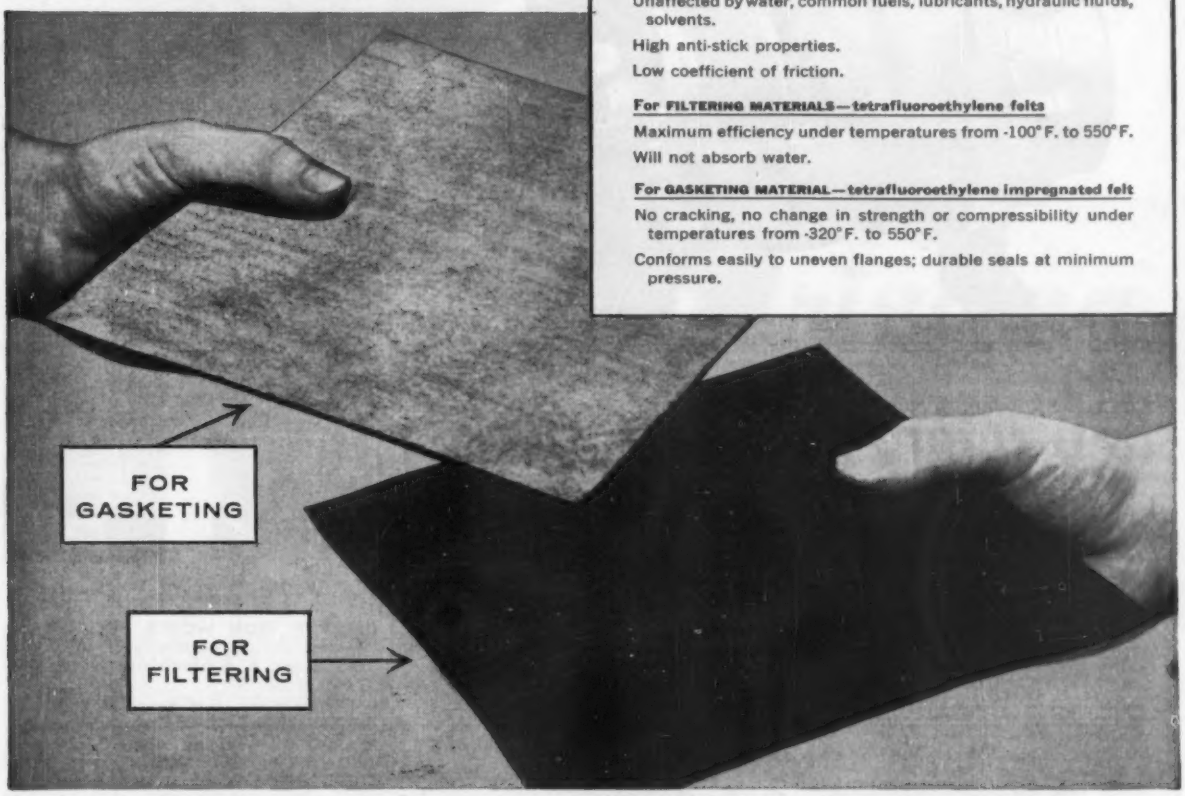
Maximum efficiency under temperatures from -100° F. to 550° F.

Will not absorb water.

For GASKETING MATERIAL—tetrafluoroethylene impregnated felt

No cracking, no change in strength or compressibility under temperatures from -320° F. to 550° F.

Conforms easily to uneven flanges; durable seals at minimum pressure.



New ARMALON® felts show exceptional service life in strong corrosives, temperatures up to 550° F.

Corrosion-resistant filters and gaskets of new "Armalon"* tetrafluoroethylene resin assure extraordinary long life felts where other materials fail entirely. They've proved their superiority in systems handling strong acids and bases—at temperatures from -320°F. to 550°F.

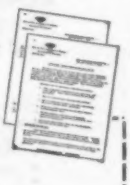
"Armalon" is the new felted form of Du Pont's "Teflon"** tetrafluoroethylene resin, available in two constructions—one for filtering, the other impregnated for gasketing†. "Armalon" is inert to water, common fuels, lubricants, hydraulic fluids, solvents and corrosive chemicals.

FILTERS of "Armalon" remove fine particles at high flow rates with minimum pressure drop. Anti-stick property of "Armalon" means longer service life, easier cleaning.

GASKETS of "Armalon" seal securely and last months, even years, longer than other materials. Advantages include substantial reductions in costly replacement shutdowns.

For more facts that may help you find a place for "Armalon" felts in your operations, fill out and mail the coupon. You'll receive Du Pont's free descriptive bulletin, including specifications.

*"Armalon" is Du Pont's registered trademark for its tetrafluoroethylene felts and impregnated felts.
**"Teflon" is Du Pont's registered trademark for its tetrafluoroethylene fiber.
†"Armalon" tetrafluoroethylene impregnated felt is covered by U. S. Patent 2,764,506.



DU PONT INDUSTRIAL COATED FABRICS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Dept. PR 712
Wilmington 98, Delaware

Please send me descriptive bulletin on "Armalon" felts.

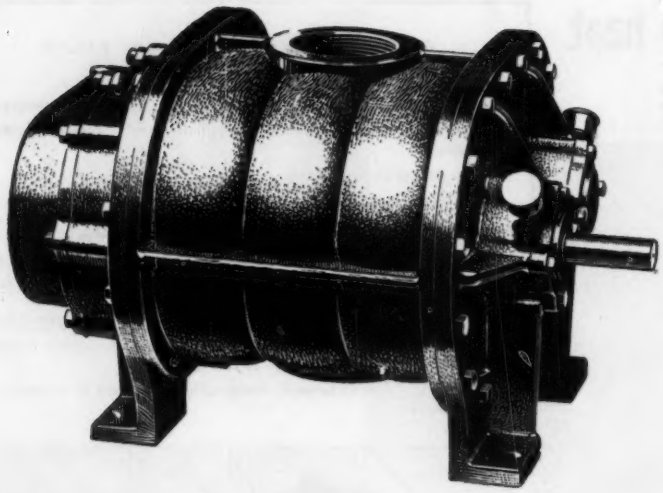
Name_____ Position_____

Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.



R-C rotary positive blowers deliver clean air in large or small volumes

Whether you require 5 or 100,000 cfm of accurately controlled volumes of air, Roots-Connersville rotary positive blowers assure performance that meets the most exacting specifications.

- No internal lubrication . . . air is free of oil vapors or moisture.
- High volumetric efficiency maintained with negligible slippage and with constant volumes delivered regardless of pressure.
- Impellers make no internal contact keeping friction loss small.
- Higher operating speeds result in reduced first cost, less weight and floor space. Horsepower is determined by operating pressure, resulting in maximum power savings.
- Drives may be direct-connected to electric motors, turbines, steam or gas engines . . . or speed reducing gears or V-belts.

In chemical, waste treatment, refining, paper and many other industries, R-C blowers have earned outstanding acceptance. R-C application engineers will welcome the opportunity to help solve your problem, large or small. Write for Bulletins AF-154 on small blowers or RB-134 on large units.

Engineers—unusual career opportunities await you at Roots-Connersville. Address your resume to Professional Employment Manager.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

1257 Crescent Avenue, Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

Suppliers . . .

ferred to San Antonio, Texas. Martin previously was with Lane-Wells Co., Farmington, N. M. Prior to joining Lane-Wells, Martin was associated with W. H. Pine Oil Co. He attended East Central State College, Ada, Okla.

ZALLEA BROTHERS, Wilmington, Del., manufacturers of expansion joints, announced the appointment of **Bogart-Bullock Co.,** Los Angeles as sales representative for its line of expansion joints and flexible connectors in the Southern California and Arizona area.

Bogart-Bullock Co. has offices at 6010 South Normandie Avenue, Los Angeles 44, Calif.

Woelfel

Daniels

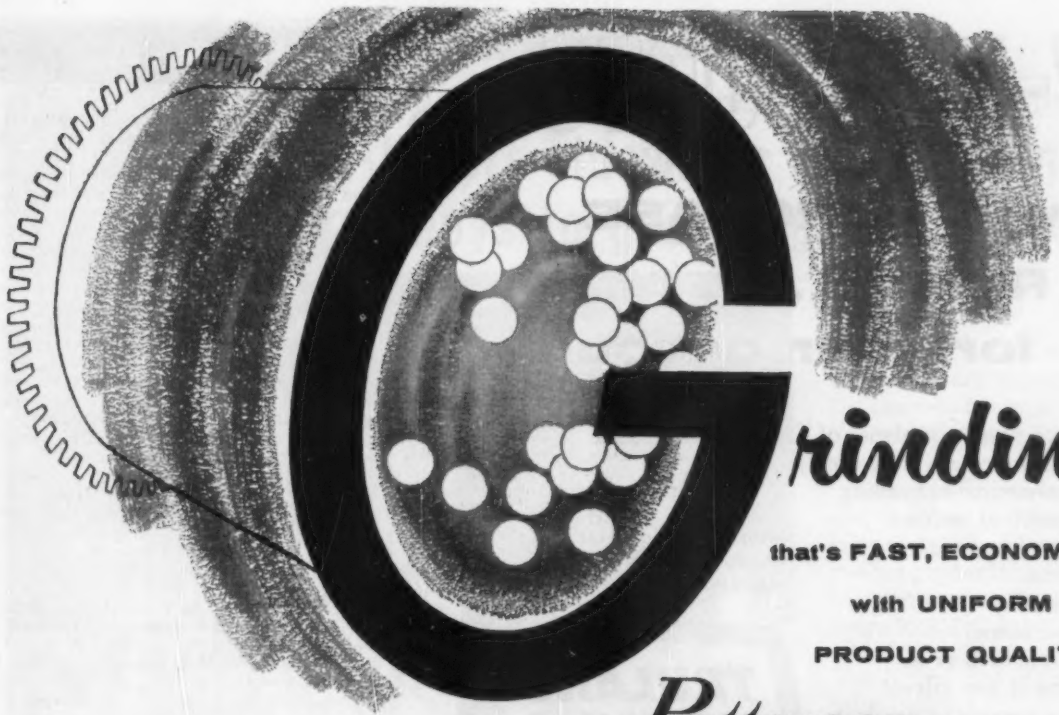
CAMERON IRON WORKS, INC. has announced the appointments of **Albert E. Woelfel** and **A. S. Daniels** to its engineering staff.

Formerly the chief design and development engineer for Ruska Instrument Corp., Woelfel will work on commercial product research and development projects for Cameron. He is a mechanical engineering graduate of the Rice Institute and after graduation served in design and development for the A-1 Bit & Tool Co., from 1947 to 1955.

Daniels has been assigned a special project to make stress studies on new Cameron products. He is a graduate of the Rice Institute with a B.S. degree in mechanical engineering and recently received an M.S. degree in mechanical engineering from the University of Idaho.

HOOKER ELECTROCHEMICAL CO. has named **Dr. Clarence A. Stiegman** technical director and **Dr. J. Howard Brown** general manager, Niagara research and development, Niagara Falls, N. Y., it was announced by **R. Lindley Murray,** board chairman.

The company has accepted with regret the resignation of **Dr. Johannes H. Bruun,**



Grinding

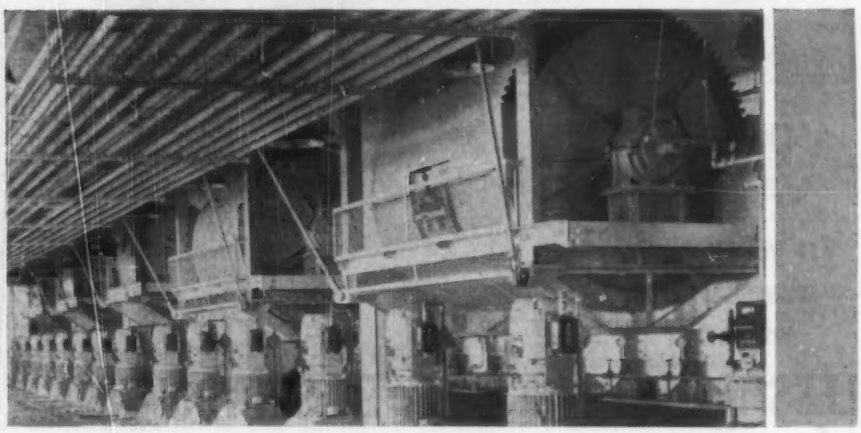
that's FAST, ECONOMICAL

with UNIFORM

PRODUCT QUALITY

...depend on *Patterson* all the way

Efficient materials handling is typified in this installation of forty-eight pebble mills and mixers at W. P. Fuller & Company, San Francisco. Mills are charged from the floor above and discharged directly into mixing tanks below.



Consistent high product quality in shorter grinding time—at lower cost! This is the net of Patterson Pebble Mill performance, integrated with specific customer operations by Patterson Engineering Service. • The factors of efficient materials handling, optimum mill speed, correct ball and material charge are vital to quality and profits. Let us relate Patterson Mills *and engineering* to your most exacting grinding requirements. Write for a prompt consultation.

ADVANCED PROCESS EQUIPMENT OF ENDURING SATISFACTION

THE *Patterson* FOUNDRY AND MACHINE COMPANY

A Subsidiary of Ferro Corporation

East Liverpool, Ohio

THE *Patterson* FOUNDRY AND MACHINE COMPANY (Canada) LIMITED

Toronto, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

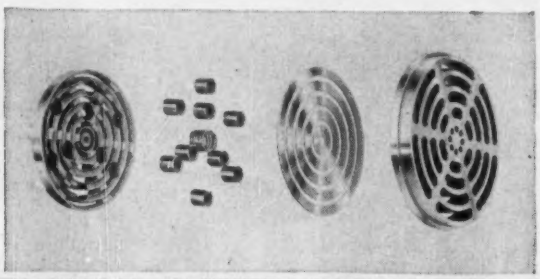
BY-PRODUCTS...

will PURCHASE or REFINE . . . for your account.

The facilities and experience of Truland may be employed advantageously for the economical upgrading and disposal of solvent mixtures and organic by-products. Our technically trained personnel are available to discuss the refining of any solvent mixture or organic by-products.

Division of The Trubek Laboratories Incorporated

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

Suppliers . . .

director of research and development. Dr. Bruun has been with Hooker for about five years.

Dr. Earl L. Whitford, a vice president and company director, will continue to coordinate Hooker's research on a company-wide basis. Responsible to Dr. Whitford in his new capacity, Dr. Stiegman will head the company's research at Niagara Falls. Dr. Stiegman, who has been director of product development since last January, also continues in that capacity under his new title, now reporting to Dr. Whitford on those activities as well.

In his new post, Dr. Brown, who had been appointed research manager in charge of phosphorus chemistry research, analytical, and physical chemistry laboratories in July, reports to Dr. Stiegman.

Dr. Stiegman, whose home town is Paxton, Ill., graduated from the University of Illinois, where he received a B.S. degree in 1932, an M.S. degree in 1934, and a Ph.D. degree in chemistry in 1937. He held a teaching fellowship at the university from 1933 to 1937.

Dr. Brown was born in Attica, Ind., and received the B.A. degree from Wabash College in 1932 with membership in Phi Beta Kappa, the M.S. degree from Vanderbilt University in 1934, and his Ph.D. degree from the University of Illinois in 1937.

ELECTRIC STEEL FOUNDRY CO. has moved into a new office and warehouse in Denver, according to Esco's district manager, **Gordon Ley.** The new facility is located at 3940 Grape Street, Denver 7, Colorado.

Office manager of Esco-Denver is **Roy Orchard.** The Esco-Denver warehouse move will not change the present dealer organization now handling Esco construction equipment products.

EMERY INDUSTRIES, INC., has promoted **Orville W. B'Hymer** to the newly created position of customer service manager for the fatty acid sales department, **G. W. Boyd,** department sales manager, announced.

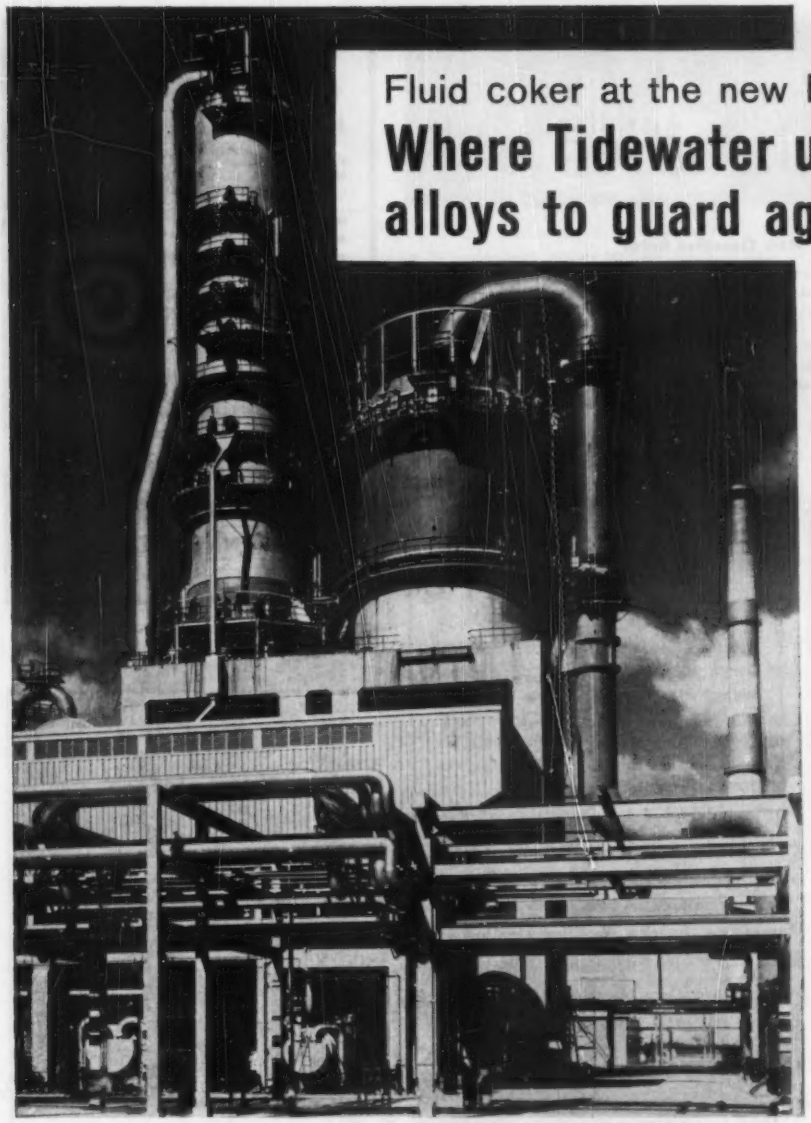
B'Hymer will coordinate customer relations in a move designed, according to Boyd, to afford more individualized attention and service for customers.

B'Hymer has been assistant to Boyd since joining Emery in 1947. He attended the University of Cincinnati Evening College.

TRACERLAB, INC., has appointed **Dr. David Bandel,** associate technical director. As the chief administrative scientist under **Dr. Wendell C. Peacock,** technical director, he will work with the commercial contract, chemistry activities of the firm.

Dr. Bandel's predecessor, **Dr. William Tittle,** left Tracerlab to accept a full professorship at Southern Methodist University where he will develop a program on reactor engineering.

From 1951 to the present, Dr. Bandel has been manager of the Chemical Research division and special technical assistant to the vice president of the Commercial Development division of American Machine & Foundry Co., (AMF) Springdale, Conn. He has been responsible for planning, administration and supervision of the chemical research and development program; advisor to technical sales, consulting services, patent department, and other engineering laboratories and subsidiary companies of AMF.



Fluid coker at the new Delaware Refinery...

Where Tidewater uses high nickel alloys to guard against corrosion

Here's the fluid coker at the Tidewater Oil Company's new Delaware Refinery, which boasts the world's largest initial capacity.

Like other units in this refinery, the fluid coker reflects latest practice in economical corrosion protection. To provide this protection, Tidewater engineers took full advantage of the properties of high nickel alloys. You'll find the details in the table below.

Throughout this ultra-modern refinery, high nickel alloys such as Monel* and Inconel* combat corrosion by mineral acids and other troublesome corrosives.

For more information, or for help with a corrosion engineering problem of your own, write Inco's Development and Research Division.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall St. New York 5, N. Y.

INCO TRADE MARK

Schedule of Use of Monel nickel-copper alloy to combat corrosion by aqueous H_2S and HCl in fluid coker at the new Tidewater Refinery**

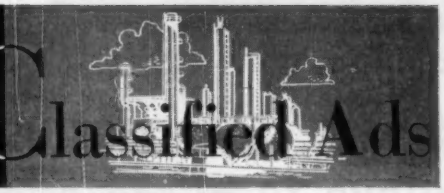
EQUIPMENT		LOCATION	MATERIAL
Columns:	Fractionator	Top head	Monel-clad steel
		Shell, tray #17 to top	Monel-clad steel
		Trays #17, 18, 19	Monel alloy
Vessels:	Fractionator-accumulator	Nozzles	Monel alloy
	First commingler drum	"	" "
	Second commingler drum	"	" "
	Stabilizer accumulator	"	" "
	Blowdown quench drum	"	Monel alloy
	Main water seal vessel	"	" "
	Bypass water seal vessel	"	" "
Pumps:	Foul water pump	Casing, impeller	Monel alloy
Piping:	Foul water line, accumulator to stripper		Monel alloy

*Registered trademark **Where temperatures go above 500°-550°F, nickel-containing type 316 stainless and stainless-clad steel are also extensively used in this unit.

INCO NICKEL ALLOYS

For more data on advertised products, use Readers' Service Cards, last page.

Petroleum Refiner Classified Ads



Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

HELP WANTED

CHEMICAL ENGINEER

Excellent opportunity with a West Coast Independent Oil Company (San Joaquin Valley). Refinery Experience, Process Design and Operation essential. Must have Engineering Degree. Salary Commensurate with ability and experience. Reply outlining personal history, photograph and work background. Box 277-R, PETROLEUM REFINER, Houston, Texas.

"Champlin Oil & Refining Co. in Enid, Oklahoma has an opening in its laboratory for an experienced refinery chemist. Applicants should furnish a brief personal history including education and professional experience. Address all inquiries to D. G. Perkins, Chief Chemical Engineer, Champlin Oil & Refining Co., Enid, Oklahoma."

CHEMICAL and MECHANICAL ENGINEERS

A large and expanding international petroleum company has openings for several Chemical and Mechanical Engineers with outstanding ability. This is a challenging opportunity to share the responsibility of coordinating international refining operations. Excellent advancement opportunities for applicants with a minimum of 3 years petroleum or chemical industry experience. Immediate assignment to our Far East refineries or to our White Plains Headquarters with an eventual overseas assignment. Salary commensurate with experience, liberal annuity, insurance, hospitalization and savings plans. Will pay moving and transportation expense. Please send resume to:

DENNIS V. WARD
STANDARD-VACUUM OIL COMPANY
P. O. BOX 1000
WHITE PLAINS, N. Y.

HELP WANTED

ORGANIC CHEMIST
Ph. D. or M. S.

For field-laboratory liaison via technical articles, lectures, and application observation. Also responsibility for laboratory organic research in water conditioning. National Organization. Replies confidential. Box No. 280-R, PETROLEUM REFINER, Houston, Texas.

MECHANICAL DEPARTMENT SUPERINTENDENT returning from foreign service. 16 years experience in refining covering maintenance and construction, instruments and operations. Desire a position with petroleum or Petrochemical company in States. Box 279-R, PETROLEUM REFINER, Houston, Texas.

FOR SALE

Save on Your
INDUSTRIAL TRACK
FOSTER QUALITY
FULLY GUARANTEED
RELAYING RAILS
Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.
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WANTED TO BUY

SMOKE STACK, APPROXIMATELY 42" DIAMETER, 100 FEET LONG, ¼" STEEL. INDEPENDENT STAVE COMPANY, LEBANON, MO.

FOREIGN
OPPORTUNITY
FOR GRADUATE ENGINEERS

PETROLEUM . . . CHEMICAL . . . MECHANICAL . . . CIVIL . . . ELECTRICAL . . . TRANSPORTATION . . . SAFETY

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AGE TO 45

Above engineers with experience in process, construction, maintenance, instrumentation, process design, inspection methods, plant equipment inspection.

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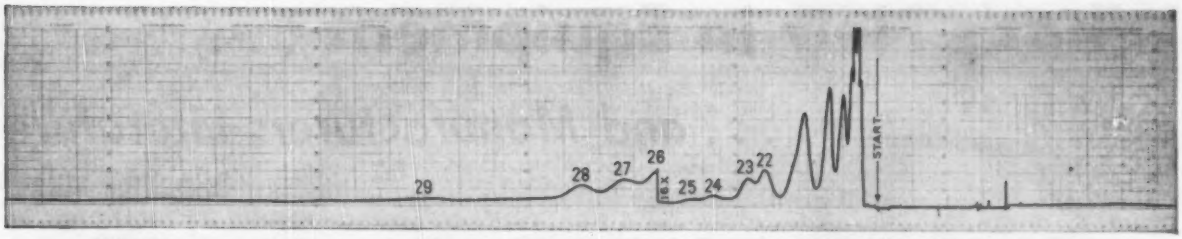
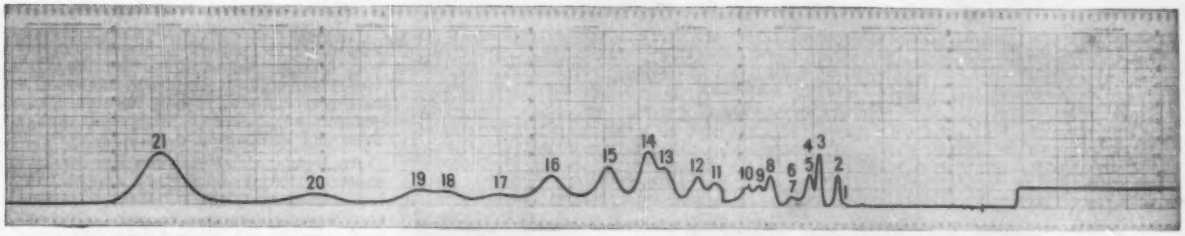
They don't cost,

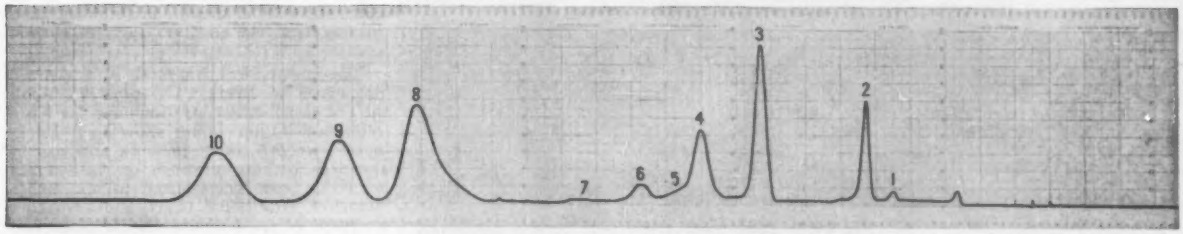
they pay.



ONE... Gasoline containing 29 components passes through the first stage of the P-E Model 188 Triple Stage Vapor Fractometer. Low boiling components pass too quickly for analysis and are diverted to stage 2. Heavy ends (components 22-29) are resolved in characteristic bands.



TWO... Light ends are still too crowded for analysis and are passed on. Medium boilers (components 11-21) are well separated and are analyzed at this stage.



THREE... Light ends (components 1-10) come through clearly in the third stage. Total analysis time for all 29 components: 25 minutes from time analysis started!

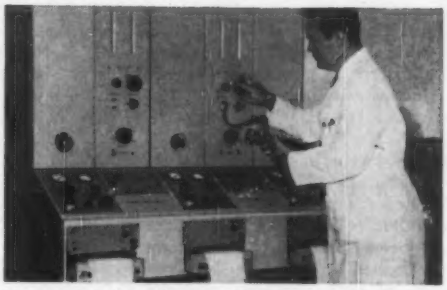
Perkin-Elmer's New Triple Stage Vapor Fractometer—

ANALYZES 29-COMPONENT GASOLINE SAMPLE IN LESS THAN 30 MINUTES!

The new Perkin-Elmer Model 188 Triple Stage Vapor Fractometer will analyze an unknown multi-component sample faster than any gas chromatography instrument in service today. The Model 188 eliminates tedious pre-separations and individual run-throughs for each set of components, thus offering considerable savings in time and efficiency over single stage instruments.

Analysis with the Model 188 is as simple as it is fast: The instrument cuts the sample three times, simultaneously analyzing high, medium and low boiling components, each under optimum chromatographic conditions. Each stage has its own recorder, and may be operated independently.

The Model 188 will analyze mixtures with components ranging from light gases to liquids boiling at 400°C. or higher, and can perform analyses not possible with conventional single stage instruments. The Model 188 is the latest in a series of gas chromatography instruments developed by Perkin-Elmer for the petroleum and chemical industries. For further information write us at 880 Main Avenue, Norwalk, Conn.



The P-E Model 188 Triple Stage Vapor Fractometer. Operator is shown introducing gas sample into second stage.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment . . .

. . . and Manufacturers Literature

Team Gives Safe Radiation Decontamination

In eleven years since radioactive isotopes have become available commercially, users of these tools in industry, have grown to over 4000. Growing use of these isotopes has increased the statistical possibility of accidents which may result in dangerous radioactive material being spilled in laboratories, factories, offices, foundries, etc. Since such radioactive materials cannot be handled with the same ease as spilled liquids or powders of the non-radioactive types, such spills have created the need for a new service—that of the radioactive decontamination technician. A meager handful of people in the United States have been trained in the safe handling and cleanup of such accidents and the recent attention which dramatically focused on the need for them as the result of a spill in Houston has resulted in this offer of a new decontamination service.

In most instances, particularly in industrial applications, it would be necessary only to remove the contamination until establishing a satisfactory health tolerance level. Small amounts of radioactivity, such as are always present in the atmosphere or in living plants, etc. and are not harmful and as long as the activity is cleaned up to such a degree that it would not rub off on the clothing of workers or would not be ingested by them, it might be perfectly safe to leave minute quantities where they had fallen.

In many instances the establishment of such a minimum health tolerance level could result in the savings of several thousands of dollars if valuable flooring, walls, partitions, etc. would not have to be removed and replaced with fresh materials.

Individual hazards associated with the various types of radiation and the various isotopes or compounds must be dealt with as separate problems and each one will be handled by the Tracerlab decontamination team as an individual case to which optimum cleanup methods must be applied. Tracerlab, Inc.

Circle E1 green card, last page

Design Data For PVC Pipe Included In New Catalogue

Where corrosion resistance or weight are factors in determining the type of piping system to install, design engineers will find a 30-page catalogue on PVC (polyvinyl chloride) pipe informative. The catalogue contains specific data on PVC's general characteristics, properties, applications and installation techniques.

An 8-page chart classifies the corrosion resistance ratings of Types I and II PVC, low carbon steel, three classes of stainless, cast iron, aluminum, copper, red brass, lead, monel, and inconel with 383 chemicals. Ratings are noted as excellent, good, limited and unsatisfactory. Listing of chemicals include organic and inorganic ranging from the strongest acids such as all concentrations of nitric and sulphuric acid to the strongest alkalines such as caustic potash.

The mechanical, thermal, and electric properties of Byers PVC pipe including ASTM test numbers are included for basic reference. Other tables show wall thicknesses, weights, burst pressure and recommended working pressure on both types of PVC from one-quarter to six inches diameter. Additional charts show working pressure versus temperature on plain end and threaded pipe. Two more charts interpret head loss versus flow rate while a final graph shows friction factors. A. M. Byers Co.

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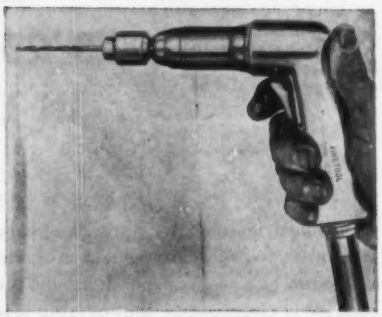


Compact Pneumatic Drill Speeds Drilling Time

Light, compact, high speed describes the new Pneumatic Drill which has been designed for drilling aluminum and other non-ferrous materials.

The Model 300 pneumatic drill has a drill capacity of 5/32-inch and is equipped with a Jacobs Keyed Chuck. Only six inches in length, and weighing just 26 ounces, it operates at speeds up to 38,000 RPM. The spindle thread is 5/16-inch-24-feet and the distance from the side of the drill to the center of the spindle is 11/16-inch.

Its small size and light weight makes

maneuvering easy in limited or difficult to reach spaces. The drill's specially styled pistol grip and trigger control assures safe, comfortable handling and easy starting, and the exhaust port may be adjusted in any direction for deflecting cuttings away from the work. The Airetool Mfg. Co.

Circle E3 green card, last page

Storage Tank Evaporation Cut With Floating Blanket

Floating plastic blankets are devices designed to eliminate the largest part of the losses, due to evaporation taking place during storage, of volatile liquids such as: crude petroleum, gasoline and motor spirits including ternary mixtures (petrol, benzol, alcohol) and also alcohols. In addition, these floating blankets insure a considerable measure of protection against fire hazards.

The floating blankets consist of a flat bottom with a vertical raised edge or skirt, and certain accessory parts.

The bottom of the blanket is in the form of a continuous flexible "carpet," the underside of which is provided with a very large number of small parallelepipedic floats arranged side by side. The impervious and independent floats and the continuous "carpet" are made of a polyvinyl chloride sheet, which is unaffected by any of the mentioned liquids. The floating blanket forms, therefore, an impervious covering. It is made "to measure" to cover the free surface of the liquid stored in the tank and so as to leave a gap of only about one inch around the periphery.

It weighs approximately two pounds per square yard and the apparent density (specific weight) is 0.2.

The floating blanket can be made of any other plastic material such as polyvinyl alcohol, superpolyamides, polyesters, fluored hydrocarbons, etc, which will enable it to work on any solvent or under any special conditions.

The vertical raised skirt provided on the edge of the blanket serves to maintain a vapor seal saturated by the evaporation of the stored liquid over the free annular surface of the liquid. This vapor seal has the effect of stopping evaporation and the only possible loss results from gaseous diffusion, which is a slow phenomenon.

Moreover, in order to imprison the vapor seal as effectively as possible, the skirt is "Z"-shaped and sufficiently elastic to come to rest against the inner wall of the tank and yet move away should it get caught in a row of rivets.

The blanket is provided with a certain number of openings fitted with vertical sleeves to enable measuring and sampling to be carried out and also to allow the float of the level indicator to pass through.

Small holes are provided for draining off water condensation.

Other valves enable the air, which may be pumped into the tank due to a slug air blowing, to escape. Laroche Bouvier & Co.

Circle E4 green card, last page

Additive Concentration Problems Solved By Chart

A convenient concentration conversion chart has just been prpared for petroleum chemists.

Suitable for use on wall or desk, the chart provides an easy and rapid means of converting petroleum additive concentrations into any of the seven units most frequently employed in the laboratory and in production. Eastman Chemical Products, Inc.

Circle E5 green card, last page

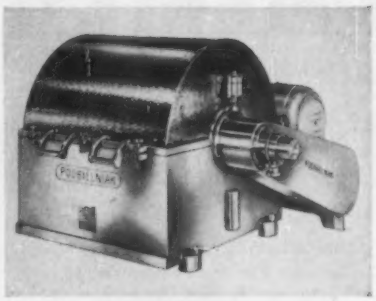
World's Largest Contactor Advances Lube Processing

This contactor makes possible almost perfect extraction in the elimination of impurities, corrosive materials, and similar undesirables found in lubricating oils. The use of contactors, for example, in the processing of lube stocks and production of sulfonate detergent additives has created marked advancement in these important processes.

With such great simplification, efficient and effective processing of numerous "stocks" is now possible even on a continuous 24-hour operation. As is well recognized, "continuous processing" is basically the only effective means of producing a high-quality lube oil or high-quality sulfonate. Podbielniak, Inc.

Circle E6 green card, last page

New Equipment . . .



No Leaks in All-Welded Feedwater Heater

Leading an advanced trend in high-pressure construction, a new spherical head, all welded feedwater heater will soon be operating in seven of the nation's newest central stations. The construction has been developed to meet the prerequisites of present-day operation, namely, high reliability and freedom from maintenance.

By eliminating all flanges and all bolted gasket-joints, the danger of leakage at these vulnerable points is entirely eliminated. The spherical head, the most economical shape in the use of material, is likewise ideal for withstanding stresses from thermal shock of quick changes in load and sudden outages.

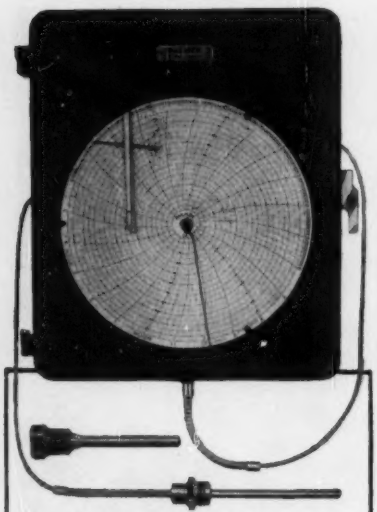
The tube-to-tubesheet joints are welded

PALMER

MERCURY ACTUATED

recorders

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer master craftsmen.



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 to 1000°F. or Equivalent in °C.

Send for Bulletin No. 45

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

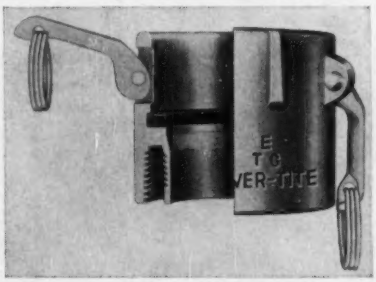
Cincinnati 12, O.

New Equipment . . .

by a controlled metallic-arc welding procedure, and are subjected to a series of both inert-gas and hydrostatic tests. External joints are automatic-welded, radiographed, stress-relieved, and hydrostatically tested to the applicable requirements of the ASME code.

Access into the spherical water-box is through a pressure-sealed manway closed by a cover, hinged inwardly. The construction of the tubebundle, its influent and effluent compartments, and its shrouded sections, all embody details that contribute to trouble-free operation. C. F. Braun & Co.

Circle E7 green card, last page



Quick Coupler Assures Full Flow of Product

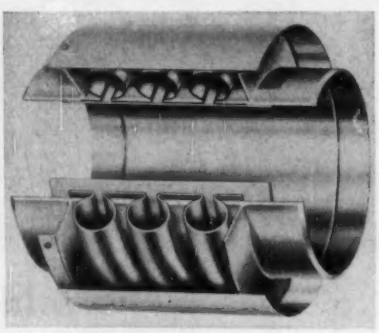
A new "M.I.D." coupler has just been introduced which is designed for gravity delivery of gasoline and transfer of other products up to pressures of 25 p.s.i.g.

The unique feature of this quick coupler is that full flow is assured by the maximum inside diameter it offers.

This coupler eliminates the necessity of attaching a conventional hose coupling, and then the addition of a quick coupling. This saves labor and money for the user, as well as giving him a light weight quick coupling.

The body portion is constructed of a single brass forging, with the additional feature of Hi-Tensile Bronze coupling means, and when used in conjunction with the company's tight fill system, it offers maximum gpm in product delivery. Ever-Tite Coupling Co., Inc.

Circle E8 green card, last page



Expansion Joints Have Corrugation Design

A new line of expansion joints for high pressure and high temperature service, embodying a recently patented toroidal corrugation design, is now available.

Known as HyPTor expansion joints,

RECTORSEAL

seals MORE joints per DOLLAR

Here's proof that Rectorseal gives you much more for your money. You not only get better, more dependable leakproof seals —but more of them from every can or tube of Rectorseal.

Here are the results of tests to determine the number of pipe joint threads that can be coated with Rectorseal and other compounds. Rectorseal coated ⅓ MORE joints than the nearest competitive brand; and 2⅓ times more than another brand.

Brand	Number of 2" pipe joints coated, per pint.
RECTORSEAL	448
Brand "A"	192
Brand "B"	224
Brand "C"	336

Start using Rectorseal now—be sure of leakproof joints, and get more seals per dollar for economy.

Rectorseal No. 2
— Dries fast
— Sets soft.

Rectorseal No. 5
—Dries slow
—Sets soft.

Both can be used for the same services. Specify your preference when writing for sample.

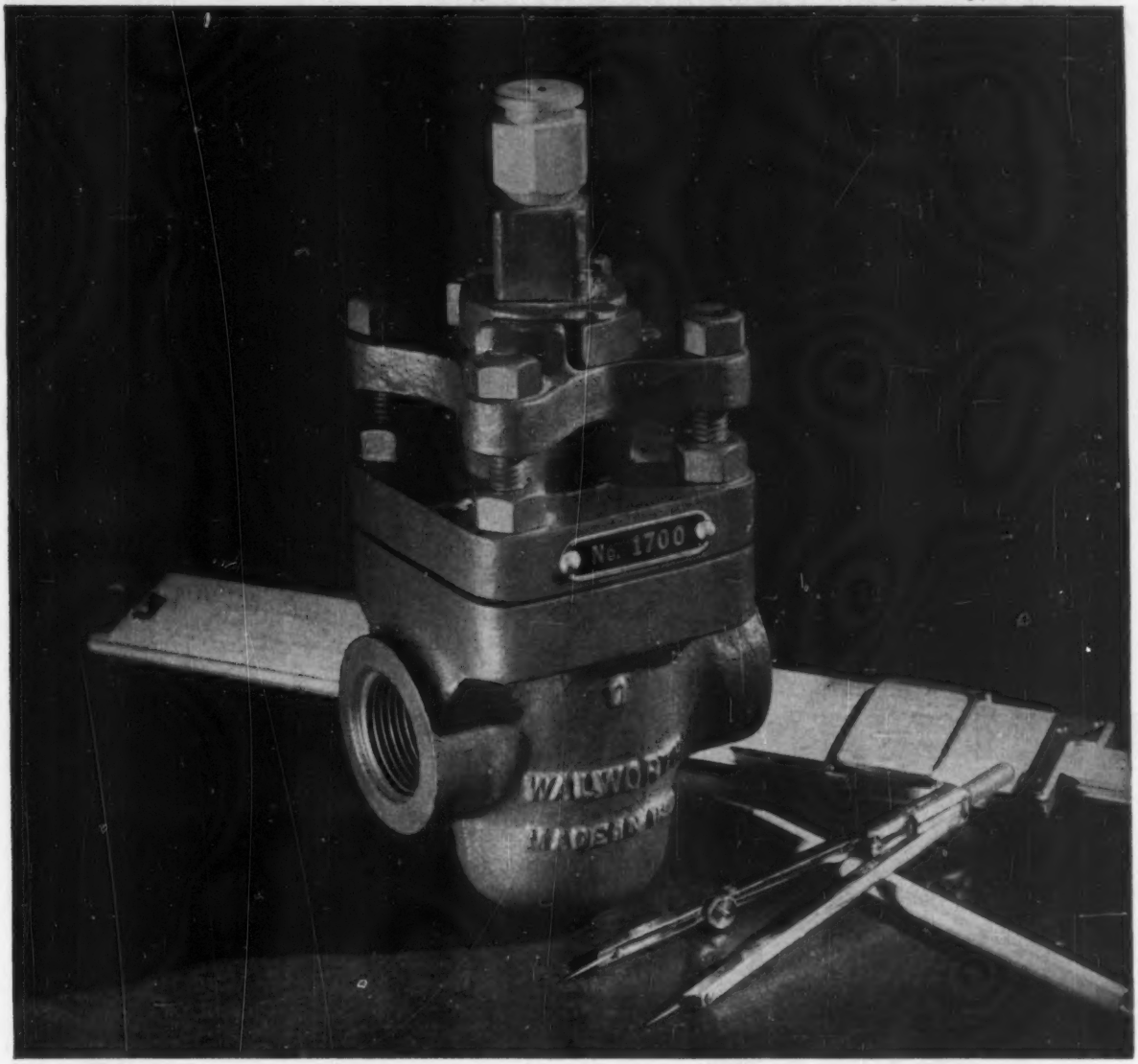
Write for Free Sample Today.

RECTORSEAL Dept. R

2215 Commerce Street, Houston 2, Texas

RECTORSEAL®
THE POSITIVE LEAK PREVENTER

Illustrated here is the Walworth Lubricated Plug Valve No. 1700, available in sizes from ½" to 5" inclusive, suitable for 200 pounds water, oil, or gas working pressure.



problem-solvers for tough jobs

*LPV's by WALWORTH

If you're familiar with the basic advantages of Plug Valves, you know why Walworth Lubricated Plug Valves work so well in really tough spots. You know about their direct port opening . . . their dead tight shut off. Seating and sealing surfaces are fully protected from attack by fluids being handled by insoluble lubricants.

*Lubricated Plug Valves

Remember, you can get Walworth LPV's in all sizes . . . from ½ to 30 inches . . . for pressures up to 5000 psi and for vacuum service . . . in a number of different styles and patterns. For more information about LPV's and for your copy of the new Walworth LPV Circular, see your local Walworth Distributor.

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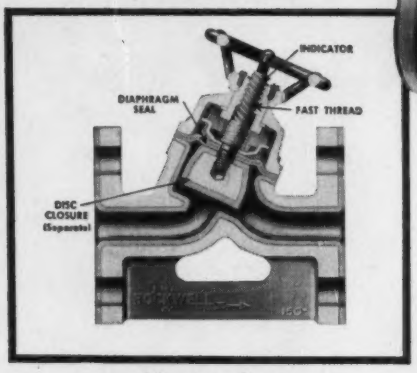
Best by Far – for Low Cost Corrosion, Abrasion, Vacuum and General Service

W. S. ROCKWELL

DIAPHRAGM VALVE



- No packing gland to leak. Mechanism not exposed.
- Oversized ports; high capacity; low pressure drop. Largest capacity of any diaphragm type valve.
- Self-draining in horizontal position.
- Closure is by rubber disc.
- Lower handwheel torque and fewer turns to close.
- Automatic control available.
- Body of any metal or with any lining.
- Sizes ½" to 6".

Always closes Diaphragm seals mechanism

Write for Bulletin

W. S. ROCKWELL COMPANY — 2367 Eliot St., Fairfield, Conn.

Quoth Sir Galvaknight: **Only Complete PROTECTION is Good Enough**

And the best *complete* anti-rust protection for iron and steel is hot-dip galvanizing. The hot-dip process seals out corrosion on *all* surfaces, as no other protective coating can. Armorplate your iron and steel with hot-dip galvanizing by the Southwest's largest commercial galvanizers, the Nowery J. Smith Company!

Nowery J. Smith COMPANY

Commercial Galvanizing

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P. O. Box 7398 Houston 8, Texas

one of the SMITH Engineered Service on Southwest

New Equipment . . .

these units protect power and process piping systems and related equipment against damage from expansion and contraction due to temperature change. HyPTor expansion joints are formed by a patented hydraulic technique, entirely eliminating the undesirable circumferential welds used on many expansion joints.

Toroidal corrugations have circular or oval cross-sections which, for any given pressure, produce operating stresses lower than any other corrugation shape. The thin-walled bellows of the HyPTor design reduces flexing stresses and substantially increases expansion joint life.

Because each toroidal corrugation is somewhat like a closed coil of thin-walled "tubing," stresses depend primarily upon the "tubing" radius and wall thickness, and are almost entirely independent of pipe diameter. Corrugation roots are fully supported without welding, so that only the concave part of the corrugation is exposed to pressure. An external cover protects corrugations from accidental damage. Zallea Brothers.

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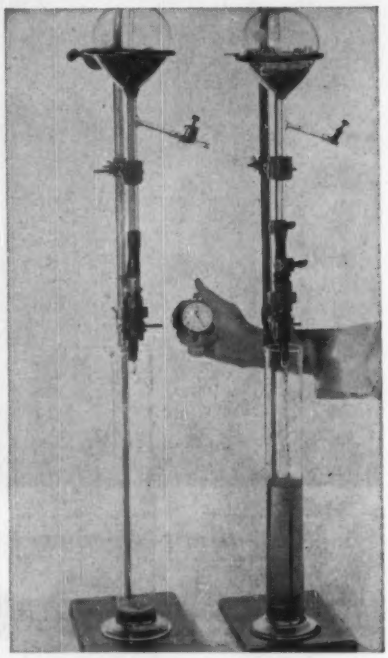
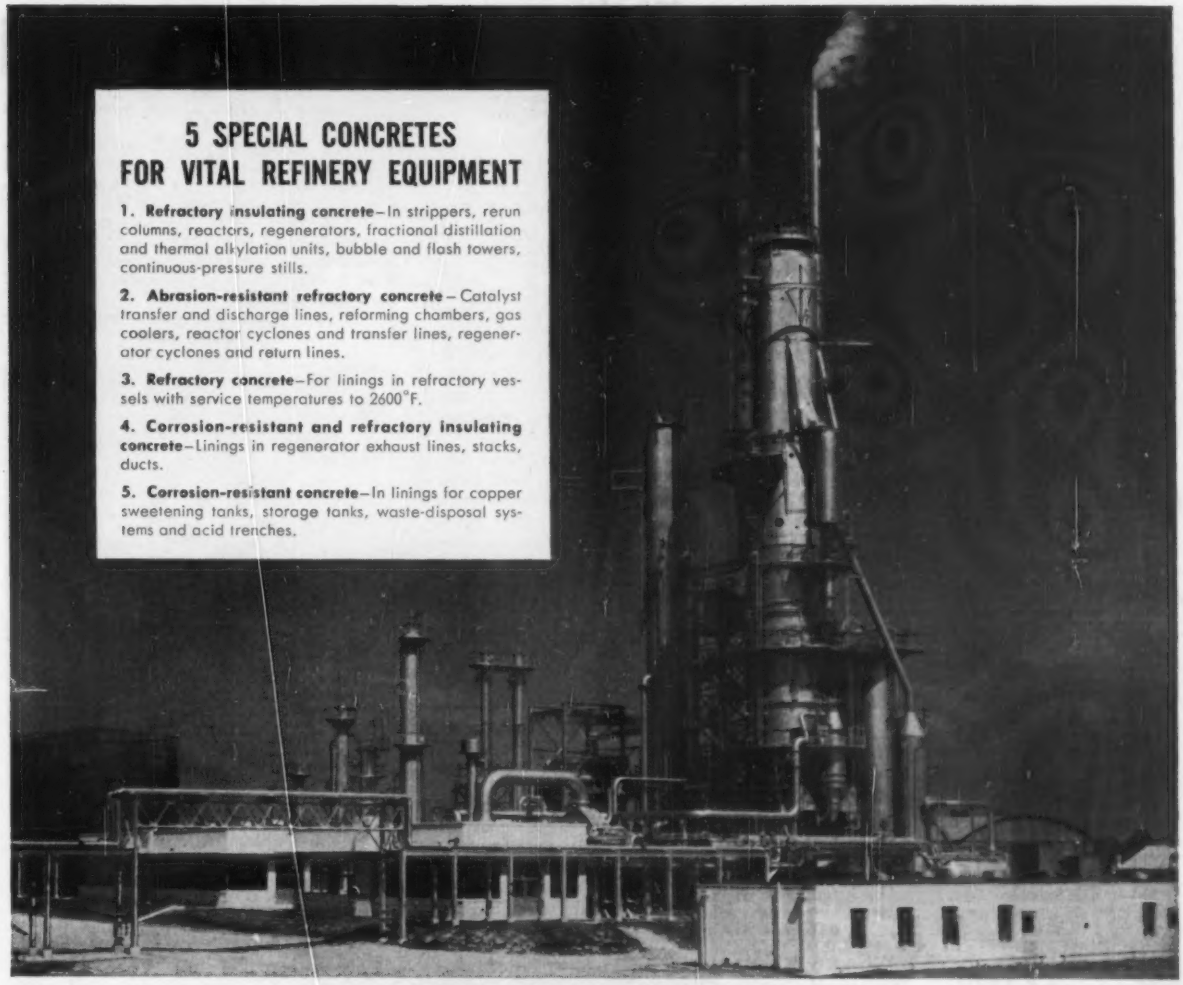


Fuel Oil Additive Stops Gum Formation In Stocks

A new line of fuel oil additives designed to prohibit gum formation in oil stocks has just been developed.

The additives, called Armolad F 20, F 22, F 24, F 25, F 26 and F 28, are fatty amine derivatives which will stabilize No. 2 fuel, or furnace, oil.

Extensive tests have shown each additive to be particularly effective with certain crude oil stocks. The F 20 additive will stabilize Mid-Continent stocks; F 22, Venezuelan, Mid-East and Mid-Continent; F 24, Venezuelan, Mid-East and Mid-Continent; F 25, effective in a variety of crudes; F 26, West Texas as well as a variety of other crudes, and F 28,


5 SPECIAL CONCRETES
FOR VITAL REFINERY EQUIPMENT
1. Refractory insulating concrete—In strippers, rerun columns, reactors, regenerators, fractional distillation and thermal alkylation units, bubble and flash towers, continuous-pressure stills.
2. Abrasion-resistant refractory concrete—Catalyst transfer and discharge lines, reforming chambers, gas coolers, reactor cyclones and transfer lines, regenerator cyclones and return lines.
3. Refractory concrete—For linings in refractory vessels with service temperatures to 2600°F.
4. Corrosion-resistant and refractory insulating concrete—Linings in regenerator exhaust lines, stacks, ducts.
5. Corrosion-resistant concrete—In linings for copper sweetening tanks, storage tanks, waste-disposal systems and acid trenches.

Universal Oil Products Fluid Catalytic Cracking Unit, McMurrey Refining Co., Tyler, Texas

Industrial concretes made with ATLAS LUMNITE* CEMENT help reduce refinery maintenance costs

- Industrial concretes made with Lumnite and suitable aggregates resist heat to 2600°F—combat corrosion—and insulate.
- Production loss due to installation or repairs is minimized because placement is fast and easy—service strength is reached within 24 hours.
- Improves efficiency of equipment—provides longer service life.

For maximum convenience, use Lumnite-made castables. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For more information write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

* **"LUMNITE"** is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

L-160

UNIVERSAL ATLAS CEMENTS

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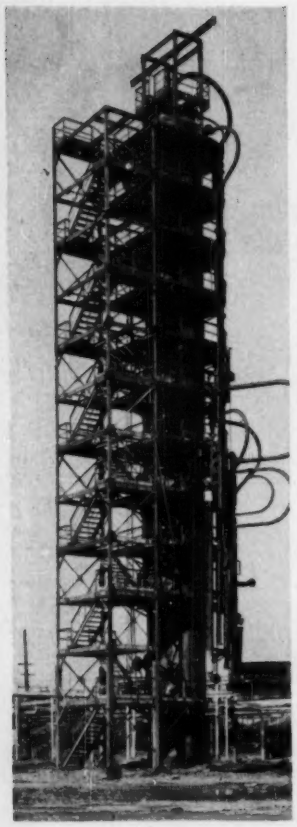

High pressure bubble tower in perfect condition

8′ ID x 95′ high from base ring to top of shell proper. Shell length is 82′6″ x 1-7/16″ thick. Skirt is 8′ OD x 12′6″ x 1″ thick. 1-7/16″ ellipsoidal heads. Bottom shell extension, 3′ ID x 5′ x 9/16″ thick. Double butt weld joints throughout. Tower lined throughout with 7/64″ 11-13% chrome U. S. S. 12 #410 stainless steel shell. Heads and shell extension fabricated from ASTM-A-70 firebox grade steel. Skirt fabricated from ASTM-A-7 plate grade steel. Tower complete with 25 bubble trays, all 12% chrome #410 S steel. Tower also c/w stairway and platforms.

Tower designed for 275 pounds per square inch, with operating temperature of 800 degrees fahrenheit. 386 pounds per square inch allowable working pressure at atmospheric temperature. Hydrostatic test pressure: 579 pounds per square inch. Shell was stress relieved after fabrication.

Shell fabricated by A. O. Smith Corporation. Stainless steel trays and caps by Fritz W. Glitsch & Sons.

Complete assembly and fabrication details, with original mill and test reports, available on request.

Call Lou Miller, Riverside 1-5055, Dallas, Texas, collect — or write P. O. Box 10387, Dallas, Texas.

MANNING & LEWIS ENGINEERING CO.
28-42 OGDEN ST. NEWARK 4, N.J.
WORKING PRESS:- SHELL TUBES
UNIT NO. JOB NO.

HEAT EXCHANGE and PROCESS EQUIPMENT

THIS NAMEPLATE IS YOUR GUARANTEE OF QUALITY

Condensers
Evaporators
Jacketed Kettles
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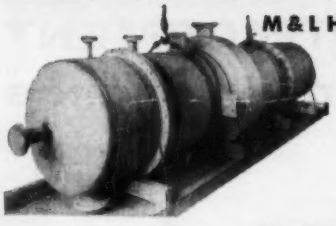


M & L HEAT EXCHANGER

CODE CONSTRUCTION: A.S.M.E.

MATERIALS: #316 Stainless steel tubes, tube sheets and heads.

PHYSICAL DIMENSIONS: Total surface: 1600 sq. ft. Shell O.D. 44″ - over 400 1½″ tubes - Expansion joint O.D. 57″. Over-all length: 19′ 6″

DESIGN WORKING PRESSURE: Shell Side - 90 lbs. Tube Side - 50 lbs.

Here is another example, among the thousands of case histories in our files, of how Manning & Lewis clearly and logically interpret customers' requirements . . . from original concept to finished quality product.

Both the saving in time and cost resulting from our years of engineering experience are two important factors why more and more manufacturers are turning to M & L.

Why not call on us the next time you need equipment. We design and construct to A.S.M.E. or A.P.I. code or we can build to non-code standards.

Please state *all* conditions of service so that we will be able to handle your inquiry promptly and accurately.

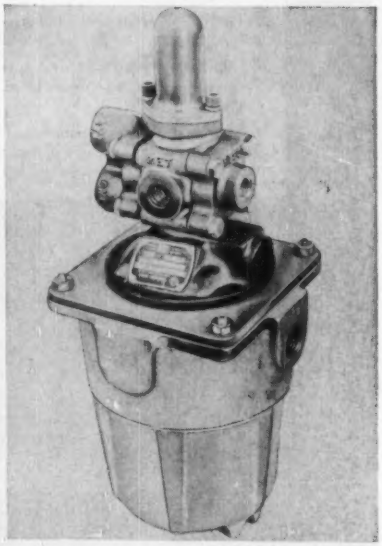
Manning & Lewis Engineering Company
DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT
28-42 OGDEN STREET NEWARK 4, NEW JERSEY
M&L

New Equipment . . .

a variety of crude stocks including West Texas.

The additives range from light amber liquids to tannish brown solid paste at room temperature. In addition to preventing insoluble gums, the Armolads protect against color degradation and improve filterability. They are effective in economical concentrations costing as little as 1 cent a barrel. Chemical Division of Armour and Co.

Circle E10 green card, last page



High Pressure Valves Have Explosion-Proof Solenoid

Solenoids are now enclosed in housings designed for hazardous locations.

Valves are rated for oil and water pressures from 0 to 250; 0 to 1500; 0 to 3000 P.S.I. and air pressures 0 to 250; 0 to 1000; 0 to 1500 P.S.I. They come in four-way, three-way, shut off and diverter flow patterns. Standard A.C. voltages are 110, 220, and 440 volts. These valves feature the "Shear-Seal" design, a sealing ring in constant intimate contact with a mating slide. The metal to metal sealing surfaces continue to lap themselves with each operation thus maintaining their sealing qualities for millions of cycles. The principle has proved itself for years in industrial applications where leakage specifications are very critical. Barksdale Valves.

Circle E11 green card, last page

Remote Tank Gage For High Accuracy Readings

The need for accurate measurement of tank contents and the parallel need of centralized information calls for an instrument which, while incorporating remote indicating facilities, is capable of giving consistently accurate readings.

The Precise Tank Gage has these requirements, giving both top and interface levels to within 2.5mm which remains consistently accurate, irrespective of tank depth.

The Precise Tank Gage can be fitted to either fixed or floating roofed tanks and provides both local and distant indi-

there's more to good construction than meets the eye

A fine construction job has a lot of eye appeal. At Procon we're pretty proud of the way our finished projects look. The most satisfaction, though, is in knowing that behind the trim, functional beauty we've put the soundness of design, the careful planning, the quality of construction to fulfill the most exacting operational requirements.

If you want your building project to function just as well as it looks, why not let Procon show you how it's done. We've been building well for the petroleum refining, petrochemical and chemical industries for years.

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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

PROCON ®

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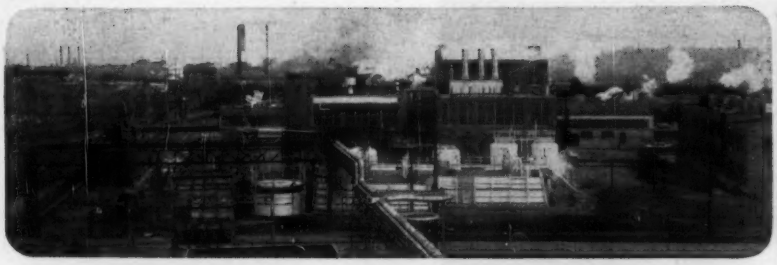
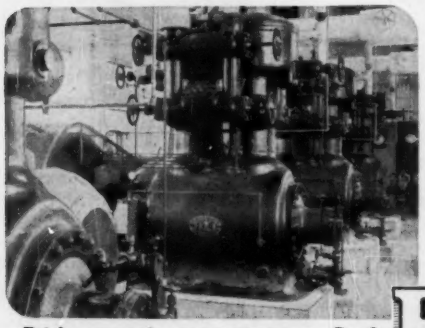


GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick". Literature and estimates on request.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

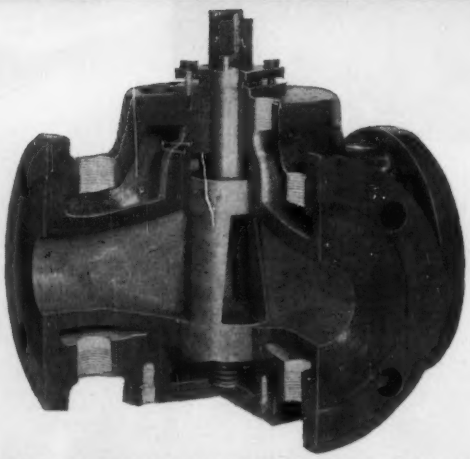
WAYNESBORO, PENNA., U. S. A.

See our exhibit in Booths 1258-60 at the Exposition of Chemical Industries, New York Coliseum Dec. 2-6.

H&B ESTABLISHED 1907

Jacketed Spring Loaded PLUG VALVES

- 2-WAY OR STRAIGHT SPRING LOADED
- 3-WAY SPRING LOADED
- ANGLE SPRING LOADED
- AIR CYLINDER OPERATED SPRING LOADED—*all sizes and types*



LONG ON SERVICE . . . SHORT ON MAINTENANCE

H & B's new fully jacketed spring loaded plug valves feature an inverted tapered plug inserted and lapped into the housing from the bottom of the valve—then spring loaded. The spring wedges the plug to a perfectly tight seal, eliminating troublesome leaks. Easy to operate—no big handwheel . . . no freeze . . . no "breaking loose" necessary. Easy to clean. Made in two port or multi port design, with any special stop arrangement desired.

Bulletin J-57 sent on request

HETHERINGTON & BERNER INC., 747 Kentucky Ave., Indianapolis 7, Ind.

New Equipment . . .

cation of the levels. The transmitter is of the null-point displacement type and is operated by the displacement of a float suspended from a winding drum and supported in part by the liquid and in part by a helical spring. One end of the spring is attached to an arm rigidly fixed to the spindle of the winding drum; the other is fixed to a disc carrying two contacts. Changes in level bring the center contact into touch with one of the outer ones, and this operates a reversible motor which causes the disc to follow the movement of the winding drum until the center contact is again free.

The local indicator registers the change in level and the action is transmitted to distant indicators by means of a power-rotor system. The transmitter consists of a rotary switch having three brushes connected to three windings in the stator of a small motor fitted in each receiver; the rotor therefore synchronizes with the position of the transmitter. Evershed and Vignoles, Ltd.

Circle E12 green card, last page

Cut Cloth Wiper Problems Also Costs With Paper

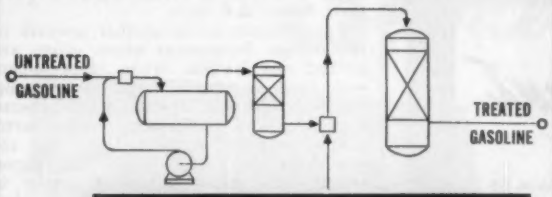
A survey conducted by a large refinery's operating personnel revealed that cloth wipers represented a substantial investment. The cost of laundering and handling cloth wipers, and replacement expense for every lost wiper, added up to a total expenditure that prompted a search for a less expensive, yet effective, means of taking care of some of the wiping chores.

The answer proved to be disposable paper wipers, now developed. Trial use of paper wipers showed them to be practical, more economical, and readily acceptable throughout most of the refinery.

One of the main advantages found in using paper instead of cloth wipers is safety, according to refinery personnel. When cloth materials were used for machine tool wiping operations, machinists were sometimes exposed to a hazard. Metal chips lodged in the fabric of a cloth wiper can cause serious cuts, scratches and infections when the workman uses the wiper for his face and hands.

This hazard has been largely eliminated because employees discard paper wipers as soon as they've used them on machines or

TC SWEETENING



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COPPER CHLORIDE

Tennessee's Copper Chloride was developed to effect efficient Mercaptans removal.

Place your confidence in a basic producer of Copper Chemicals.

CUPRIC CHLORIDE DI-HYDRATE

Other products of interest—
Ferric Sulfate—Copper Sulfate,
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For samples make request on your company letterhead.

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STEEL PLATE

custom fabricated on the West Coast

Save on transportation costs, manufacturing time and put yourself in a more competitive position by contacting an experienced "on the spot" source when planning the procurement of process and plant equipment for the West Coast. Send prints for prompt quotation on your next job.

Request Brochure No. K-57

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PUGET SOUND FABRICATORS, INC.
Craftsmen in Metals
3670 E. Marginal Way • Seattle 4, Wash.
Craftsmen in steel plate and alloys up to 1"

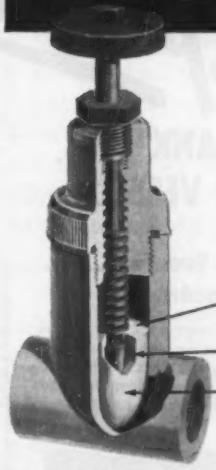
Your
STRUCTURAL STEEL and STEEL PLATE FABRICATION
ON TIME!

We pride ourselves for "on time" delivery. Thoroughly experienced staff of designers, engineers, and fabricators, to furnish the steel you want, when you want it. AISC members. ASME pressure vessels, tanks, heat exchangers, as well as structural steel. Location served by SP and MP railroads, and our dock is on the Intracoastal Waterway. Write, wire or phone for FACT FILE on our complete facilities.

ST. MARY IRON WORKS, INC.

Steel Fabricators for over Half a Century
FRANKLIN, LOUISIANA PHONE 820

NEW! ALL-PLASTIC GATE VALVE



VANTON
*FLEX-PLUG** VALVE
½"- 2" sizes

- No-pressure-drop construction of gate valve
- Throttling flow-control feature of globe valve
- PVC or styrene-copolymer construction
- Handles wide range of corrosives and slurries

- Back-seating feature of cap: when valve completely open, relieves pressure on packing.
- Free-to-swivel plug: provides even wear of cap, perfect closure.
- Flexible synthetic cap: easily replaced without removal of valve from line; minimal maintenance. Handles abrasive slurries without wear.

- All-plastic design — PVC or styrene-copolymer. Replaceable caps available in Neoprene, Buna-N, and Hypalon (Kel-F elastomer on special order).
- Suitable for vacuum—resilient cap makes excellent seal.
- Adaptable to all existing plastic pipe and fittings; especially suited to Vanton P, S, and N lines of plastic pipe and fittings.
- Rated for 150-lb. service—PVC line up to 140°F., styrene-copolymer line to 170°F.

*Pat. Pending

Catalog FP-1 gives full details. Write for it today!

VP VANTON PUMP and Equipment Corp. • Hillside, N. J.
DIVISION OF COOPER ALLOY CORP.

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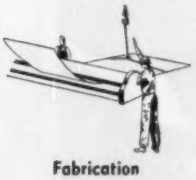
DURAMETALLIC Packings
VALVES
CENTRIFUGAL PUMPS
Throughout your plant
. . . wherever you have stuffing boxes to be repacked, specify Durametallic "Engineered For The Job" products for longer packing life and satisfactory sealing service.
Write today for our packing File No. PRDM
DURAMETALLIC CORP.
KALAMAZOO, MICHIGAN
COMPRESSORS
RECIPROCATING PUMPS

Specialists

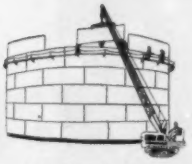
IN TANK AND VESSEL—



Fabrication

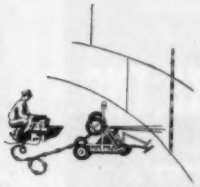
Design, Fabrication, Erection, Testing and Repairs

Tanks and vessels—from the first preliminary design to the finished job, completely tested and ready for service—are our exclusive interest. We have no other departments. Every thought is given to producing the very best tank or vessel possible. Next time, let us figure your requirements—whether it's one tank or a hundred-plus tank farm installation.



Erection

ELLERBEE BROTHERS



P. O. BOX 857 PORT ARTHUR, TEXAS X-Ray Testing

New Equipment . . .

equipment—and use fresh wipers to clean their hands and faces.

Paper wipers solved another problem in the salvage department where valves are ground and lapped. When cloth wipers were used to remove lapping compound from valve parts, a number of wipers were required. As a result, compound-smeared cloth wipers had to be collected and returned to the storeroom. With paper wipers, this messy chore no longer is necessary because soiled wipers are discarded immediately in refuse receptacles.

Personnel in the fluid catalytic cracking control room find the convenience of the paper wipers gives them more time for checking pressures, temperatures, and other production variables.

Soiled paper wipers are deposited in metal containers that are removed daily from refinery departments and emptied into the refinery incinerator. Scott Paper Co.

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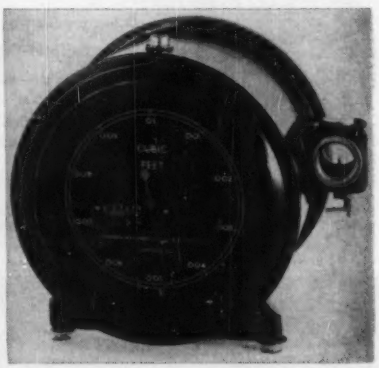

Pilot Plant Test Meter On Stream For Months

Announcing the development of a new test meter for pilot plant use. These meters were especially designed for pilot plant and laboratory service. Other meters were lasting from two to three weeks. This meter has been on stream in pilot plant operation for many months.

It will measure 40 cubic feet per hour or 1000 litres per hour. Height, 13 inches; width, 15 inches; back to front, 15 inches. Maximum operating inlet pressure is 10 inches W. G. Construction, stainless steel. Parkinson and Cowan Industrial Products.

Circle E14 green card, last page

Paste-Like Epoxy Resin Hardens Chemically

Metalset A4 is epoxy resin compounded to paste-like consistency with aluminum and other materials. It is a 2-component system. The resin (Part A) must be mixed with its hardener (Part B) just before use. The combination will harden by chemical action at room temperature (77 F) into a metallic solid which is both machinable and chemically stable.

A4 is very easy to measure and mix, even in small amounts. It adheres strongly to steel, iron, aluminum, wood, and ordinary glass. When machined its color approaches that of cast aluminum.

Use it to smooth, fill, or bond metal

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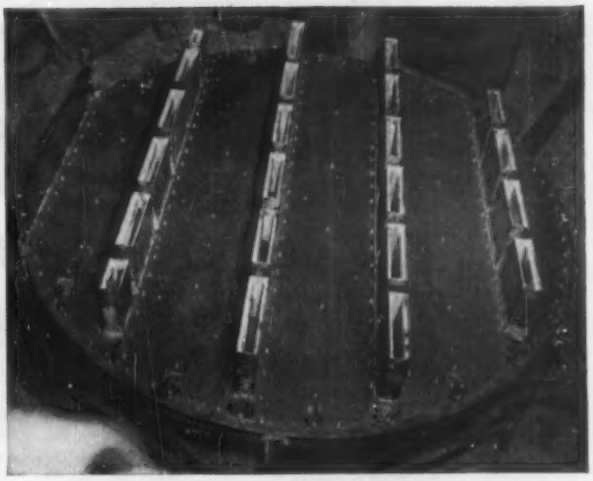

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Now you can equip fractioning towers with internals fabricated of Hendrick perforated metal plate. Hendrick "custom-tailors" perforated metal decks in commercially rolled metals and gauges to meet your own detailed specifications. Modern Column Internals produce greater capacity . . . reduce high cleaning and replacement costs caused by fouling and corrosion. And they're fabricated of Hendrick's own perforated metal . . . clean cut perforations assure uniformity of mesh and long service life. For more detailed information mail the coupon below and let us set up a date to meet with your process designer.

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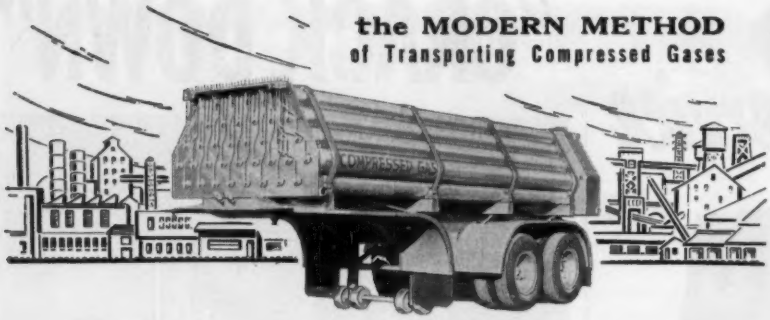

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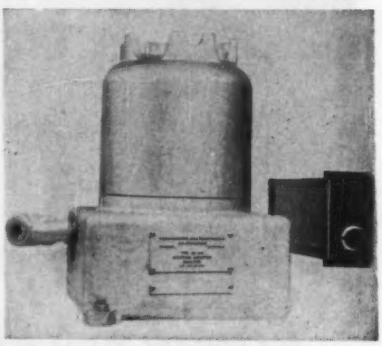
New Equipment . . .

surfaces, or to fill seams, cracks, or holes in wood or metal. It is waterproof, and highly resistant to acid and alkali. It is oil and gasoline-proof. Use it to seal leaking tanks or vessels, as a smoothing compound, as a marine caulk, for a foundry cement. Since it hardens chemically, Metalset can be applied to any thickness at one time. There is no solvent. It is not flammable.

Epoxy resin compounds harden because of the heat caused by the reaction between curing agent and resin. In other words, they set up chemically, they don't "dry." The greater the mass of catalyzed compound, the faster the cure will be. The smaller the mass, the slower the cure. Small applications will harden at 75 F within a few hours. Hardening can be greatly accelerated with gentle heat from any source—15 minutes at 175 F. To develop maximum strength it will be necessary to warm all very small applications.

Metalset A4 should not be exposed to a heat greater than 250 F in continuous service. Smooth-On Manufacturing Co.

Circle E15 green card, last page



Moisture Content Measured To Accuracy of One PPM

A new instrument for the continuous accurate measurement, remote recording, and control of low moisture levels is now available.

Called the Type 26-310 Process Moisture monitor, the instrument is built to give trouble-free service under the rugged environmental conditions of process

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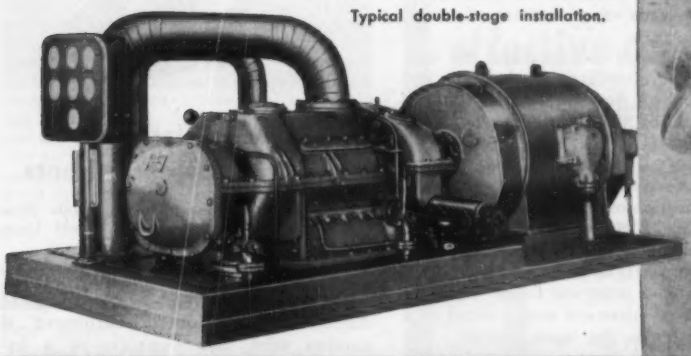
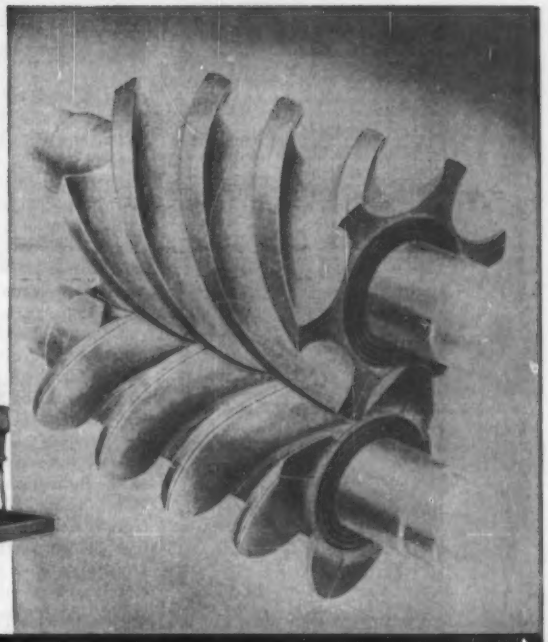


Typical double-stage installation.



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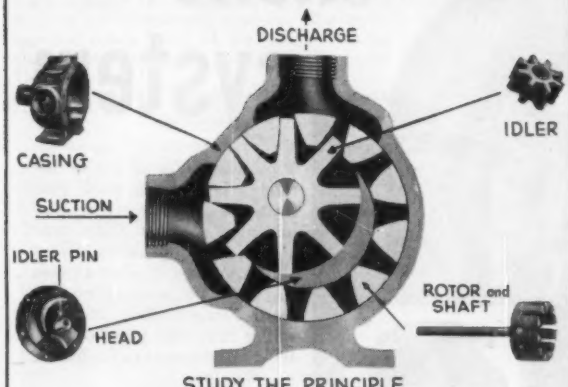
Viking Operating Principle



STUDY THE PRINCIPLE

Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

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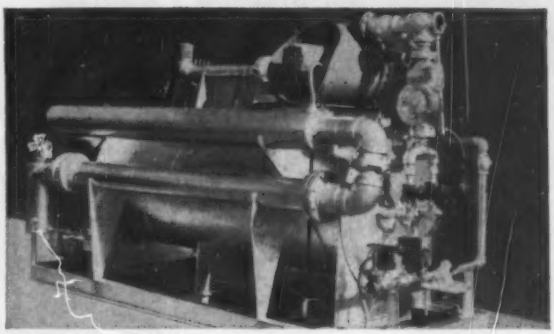

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New Equipment . . .

plant locations. It is ideally suited for monitoring moisture content of instrument airstreams. It may be used for recording moisture levels of feed streams in low-temperature distillation units and in polymerization units. Other applications include monitoring dehydrating towers in gasoline plants, monitoring the effectiveness of air dryers in process plants, and measuring water-vapor content of stored petroleum gas.

The analysis is accomplished by continuously and quantitatively absorbing and electrolyzing all water present in a sample stream entering the instrument. The electrolysis current, which is related directly by Faraday's Law to the mass rate-of-flow of water into the instrument, is used as the indication of water content.

The heart of the instrument is the electrolysis cell, in which both the absorption and electrolysis take place simultaneously. It consists of a tube which has a pair of closely spaced platinum wires wound in a double helix on its inner surface. The space between these wires is coated with a viscous film of partially hydrated phosphorous pentoxide. A d-c voltage is applied to the elements of the cell and the electrolysis current is monitored with a 10 or 50 MV potentiometric recorder. Consolidated Electrodynamics.

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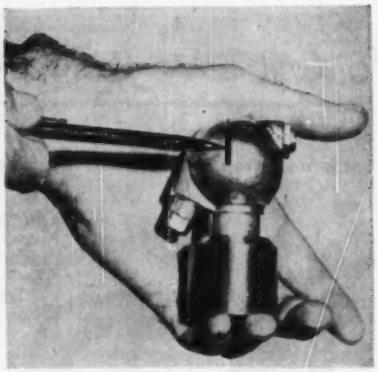


Rotary Head Used To Clean Tank Compartments

A new unit, designed to clean tank truck compartments up to 12 feet long, has just been introduced.

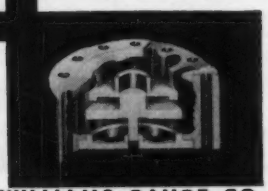
The Spray-O-Mat is a portable unit, weighing only seven pounds and measuring less than two and one-half inches in diameter. It is carefully engineered of stainless steel, and consists of a hydraulically propelled rotary head which turns on a self-cleaning, hardened stainless steel ball race. The spherical head is fitted with one wide angle nozzle, and is slotted to provide three-directional spray. An adjustable offset jet permits spinning of the spray head. The unit is fitted with a length of three-quarter inch brass pipe,

silent system

Piping systems in every industry have been made free from troublesome water hammer . . . free from dangerous surge pressures. *Silent* Check Valves eliminate these hazards by operating instantly when flow reversal starts or when flow is zero. *Write for descriptive Bulletins.*

Globe type for 3" to 24" lines.

Center-guided type for lines from 1" to 10".



WILLIAMS-HAGER
Silent
CHECK VALVES

Write for Bulletins No. 654 on the Valves; No. 851 on Cause, Effect and Control of Water Hammer

THE WILLIAMS GAUGE CO., INC.
151 STANWIX STREET
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New Equipment . . .

which is threaded to accommodate solution hose.

The new unit requires a minimum of auxiliary equipment: pump, pipes and valves, solution and drain hose, and solution tank. The pump should be capable of discharging 40 gallons per minute at a head pressure of 60 pounds per square inch. The pump discharge is fitted with a valve and tee with pressure gauge, and connected to a length of one inch ID hose which leads to the unit. The solution tank should be of 100 gallon capacity, and equipped with steam pipe or plate coil for heating the solution to the proper temperature. The tank is fitted with a drain and pump suction line which is the same size as, or larger than, the pump intake. The suction line should have a fresh water connection of 40 gpm capacity. A large drain hose is used to return solution to the tank for recirculation. Oakite Products, Inc.

Circle E17 green card, last page

Fire-Resistant Lubricant For Air Compressors

Major savings in air compressor maintenance costs and greater safety from flash fires and explosions can be obtained with Pydraul AC, a fire-resistant synthetic lubricant for air compressors, according to a booklet on the product just published.

Carbon deposits on exhaust valves and in interstage equipment are drastically reduced with the lubricant's use, the booklet states. Some users of the fluid are reported to be obtaining 15 to 20 times longer operation between clean-outs of their air compressor systems.

By minimizing carbon deposits and resisting oxidation, Pydraul AC also serves to eliminate what are believed to be the basic causes of explosions and receiver fires in air compressor systems. The autoignition temperature of the fluid is greater than 1100 degrees F. Monsanto Chemical Co.

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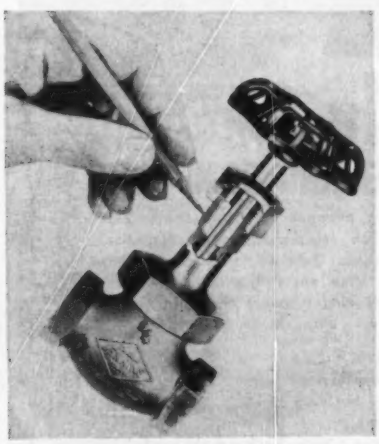

Teflon Valve Packing Has High Strength, Long Life

A virtually universal value stem packing for medium temperature service has been introduced. The new packing material, designated Style 5022, is a molded type valve stem packing ring made from

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EPOXY TAR COATINGS

effective corrosion resistance at less than 1¢ per mil foot

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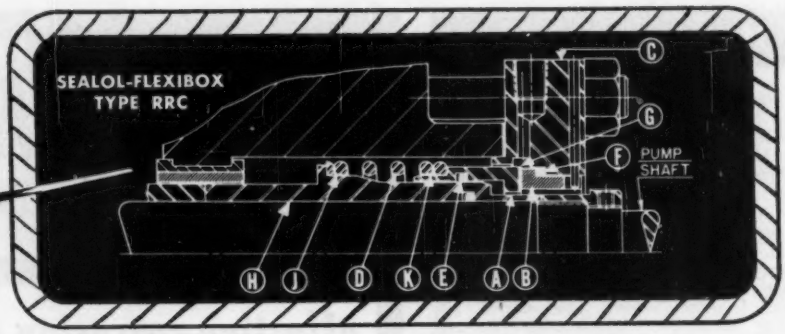
what is your SEAL IQ?



Q. Which are the rotating components of the above seal assembly?

A. In addition to the shaft; sleeve (H), drive spring (D), rotary seal ring (A), and rotary seal ring packing (E), all rotate with the shaft or rotor assembly.

Q. What turns the rotary seal ring?

A. Torque is applied uniformly through the unique Flexibox spring (D) by means of interference fits at points J and K. No pins or lugs are required.

Q. What is the suitable pressure range for the seal shown on the blackboard?

A. The design illustrated is a hydraulically balanced seal suitable for pressures up to 1000 psig.

Q. Where are the sealing faces?

A. Sealing faces are shown at point G where the rotary seal ring contacts the stationary seal ring face.

Q. How is the seal adjusted to set spring loading?

A. Integral sleeve (H) is designed to fit the pump and no adjustment or mechanical settings are necessary.

Q. How is frictional heat removed from the stuffing box cavity?

A. The Flexibox circulating type gland (C) provides product flow directly at the sealing faces.

Let Sealol Engineers solve *your* sealing problems on pumps, agitators, mixers and compressors. Request Bulletin No. 10.

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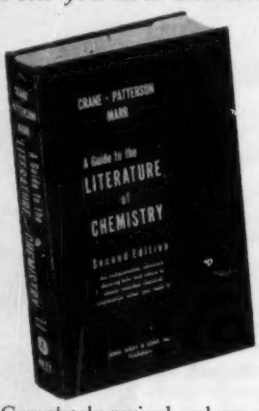

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copper wire inserted asbestos yarns which are braided and impregnated with Teflon suspensoid and die formed into rings.

Heart of Style 5022 is the Teflon which gives the packing unique characteristics and extreme versatility. Style 5022, has:

(1) Mechanical strength and extreme toughness. It is dense and firm, does not allow seepage and can withstand a great deal of physical abuse.

(2) Teflon acts as lubricant thereby eliminating graphite or liquid lubricant that tends to dry out, burn out or exude.

(3) Heat resistance. It is serviceable at temperatures up to 500 F and exhibits low flow under high pressure.

(4) High degree of chemical inertness. There is no known solvent for Teflon. It is unaffected by all known chemical agents, excepting molten alkali metals. Style 5022 can be employed where equipment is operating in contact with corrosive materials or under corrosive atmospheric conditions.

(5) Non-contaminating. Will not debase or discolor the product handled. The Garlock Packing Co.

Circle E19 green card, last page

Meters For Liquid Butane Described In Bulletin

A new eight-page bulletin combines, for the first time, descriptions of liquid meters for measuring liquid propane, liquid butane and liquid propane-butane mixtures.

In addition to product descriptions and illustrations, the new bulletin features a two-page drawing-illustrated explanation of the over-all "Rockwell dispensing system," which is designed to insure that the product remains in a liquid state throughout metering.

Basic elements of LPG liquid metering systems are shown in proper position, and a drawing of a typical vapor manifold arrangement for an LPG system is included. Four schematic drawings show how various types of liquid LPG meters may be installed with various accessories such as restricted vapor flow connectors, strainers and check, stop, by-pass, differential and excess flow valves. Rockwell Manufacturing Co.

Circle E21 green card, last page

New Equipment . . .

Data On 350 Chemicals In Physical Properties Book

The new 1958 "Physical Properties" booklet has just been issued. This 28-page booklet presents the latest physical property data on more than 350 organic chemicals. An alphabetical index is included for the convenience of the user.

Fifty new chemicals introduced by the company since the previous edition are featured. Viscosity index improver D and Crag Sevin experimental herbicide are two of the new products described in the section on chemicals for special applications. For easy reference, other chemicals are arranged by related chemical groups with condensed application data. Union Carbide Chemicals Co.

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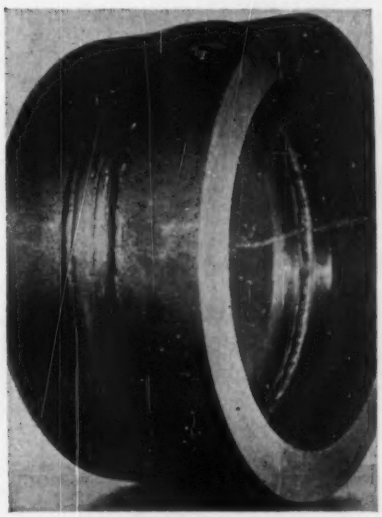

New Arc-Welding Process Makes Butt-Joints Easily

An arc-welding process which eliminates the need of metallic backing rings or inserts, when welding butt joints in pressure piping systems, is now being successfully applied.

In chemical and petroleum installations where it is necessary to produce a uniform inside bead condition, this inert-gas-shielded welding procedure is used.

Major feature of the technique is the novel manner of preparing the root edges of the joint. Root edges are bent to produce an internal circumferential lip. When edges of this type are fused together in an inert gas atmosphere, the inevitable concave condition associated with fixed position yield welds is eliminated.

Another innovation of the process is the method of burning up the paper dams with an oxy-acetylene flame or stress relieving coils. Experience to date indicates that the costs will be lower and quality superior to other techniques.

The photograph shows a finished weld showing smooth submerged arc welding beads and the uniform condition of the inside. Stone & Webster Engineering Corp.

Circle E20 green card, last page

Ductile Iron Valve Passes Quench Test at 1350 F.

In a new application of ductile iron, a metal which has the high corrosion resistance of cast iron and the good mechanical properties of steel, refineries may have a solution to their safety problems of fire and corrosion in piping systems.

Thermal shock tests on ductile iron valves show that they have a resistance equal to that of the more expensive steel valves. A valve, taken at random from stock, was mounted over a pool of oil a[t] just off the nozzle of a gas line. The [oil] fire and gas flame turned the valve r[ed] hot. After about twenty minutes of f[ire] the valve reached 1350 F. The valve w[as] water quenched (see photo) while [at] 1350 F without shattering under t[he] thermal shock as would a cast iron valv[e]

Aside from a scorched look, the valv[e] was substantially the same in appearan[ce] as before the test. It kept its shape a[nd] dimensions. Walworth Co.

Circle E23 green card, last pa[ge]

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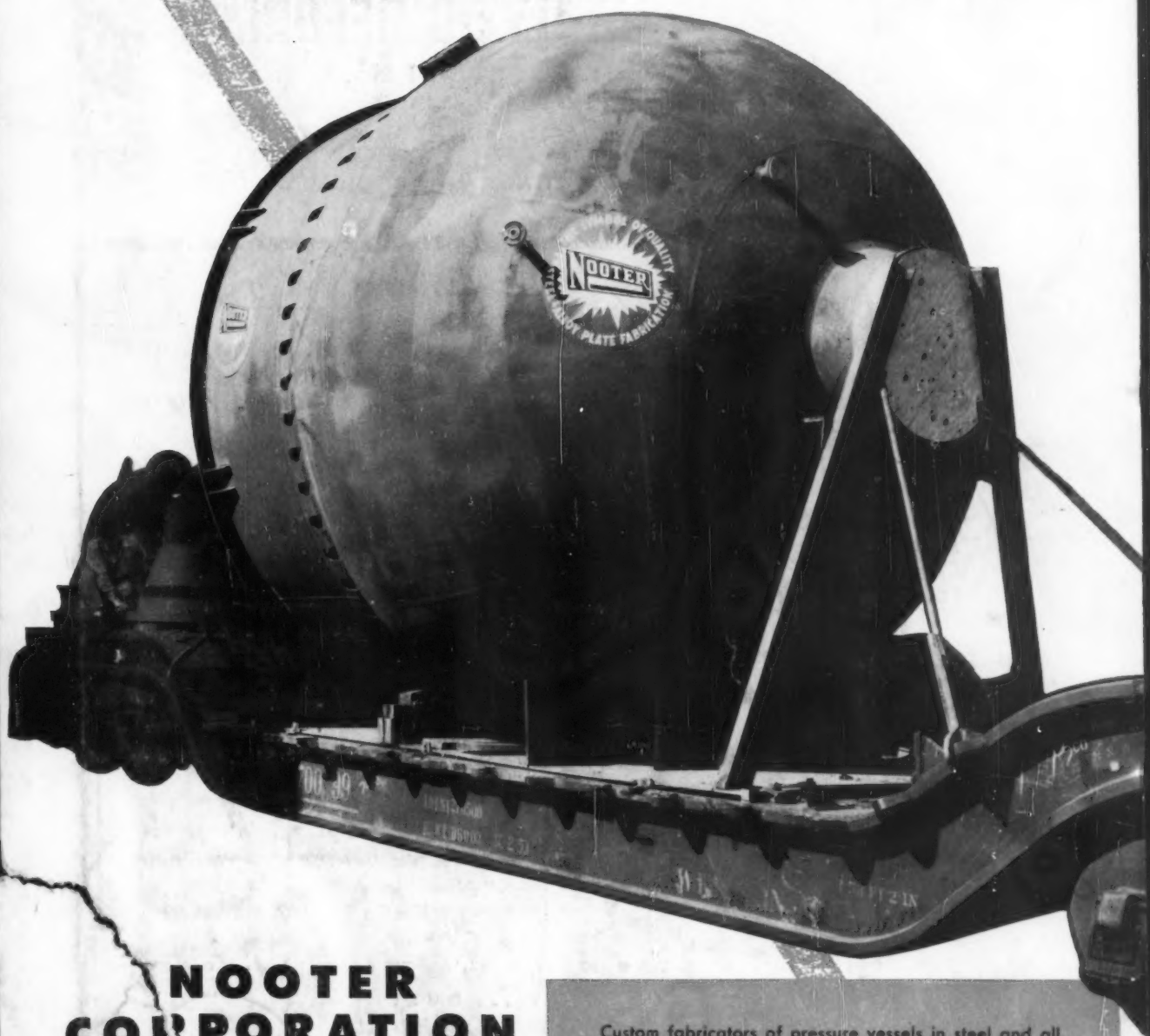

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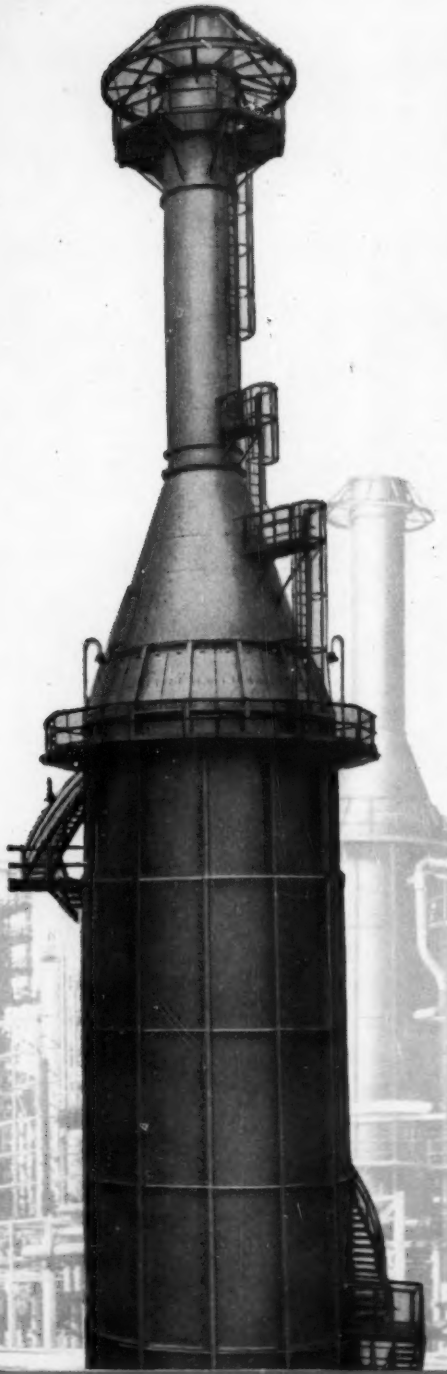

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